Mesozoikum

Moderní mořské fauny

převažují mlži, gastropodi, kostnaté ryby (Actinopterygii – Holostei, Teleostei, gymnolematní mechovky, živočišné houby (Desmospongia), ježovky, ammonoidi, belemniti, šestičetní koráli, mořští plazi,

Terestrické fauny

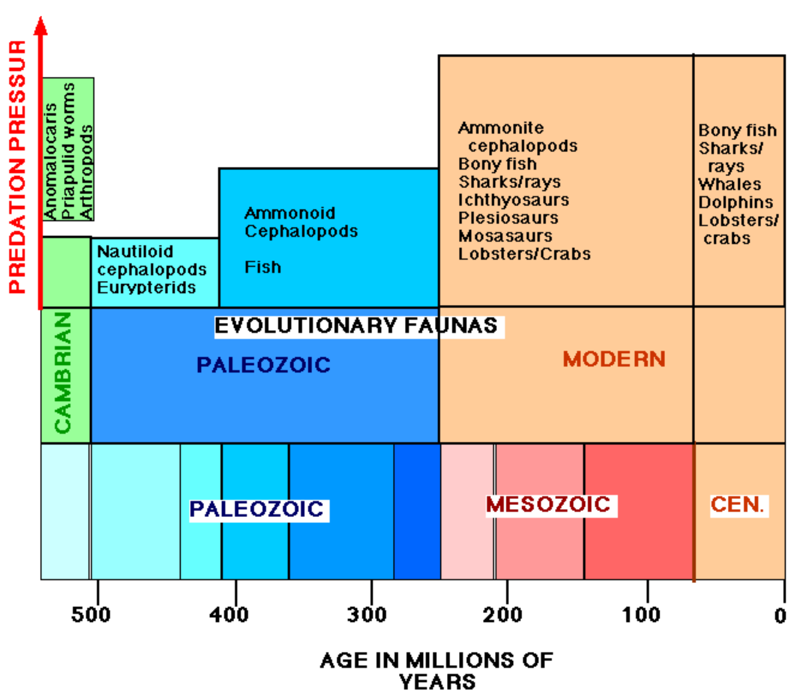
dinosauři, pterosauři, první ptáci, první savci.

Terestrická flóra

Převažují nahosemenné rostliny (trias – spodní křída), první krytosemenné rostliny, hranice **Mesofytikum** – **kenofytikum** (střední křída)

Rozpad Pangey, oceány Tethys, Indický oceán, Severní ledový oceán

Alpinská orogeneze – uzavření Tethys, mladá horská pásma s příkrovy (Atlas – Himálaje).



Báze triasu is defined at the first occurrence of the conodont species *Hindeodus parvus* in the evolutionary lineage *Hindeodus latidentatus - Hindeodus parvus - Isarcicella isarcica* at the base of Bed 27c in the Meishan Section, Changxing County, Zhejiang Province, China

Báze jury – FAD Psiloceras spelae

Báze křídy - Guide event is undecided

Báze terciéru - Iridium geochemical anomaly. Associated with a major extinction horizon (foraminifers, calcareous nannofossils, dinosaurs, etc.);

Chronostratigrafie

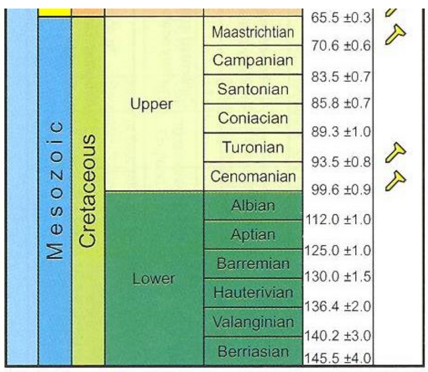
Trias (trojné dělení)

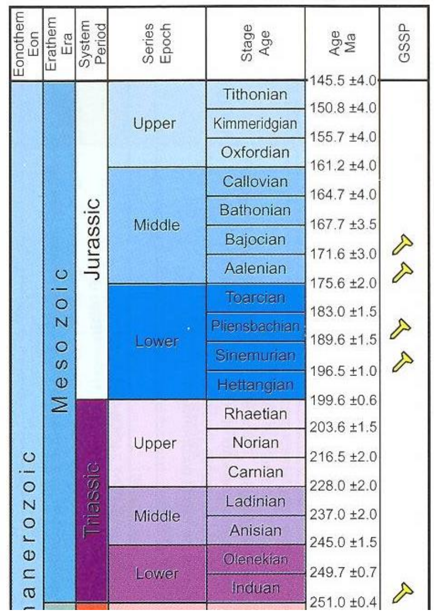
Jura (pohoří jura, Alpy)

Křída (křídonosný útvar „Cretaceous“)

STÁŘÍ (Ma)	ERATEM	ÚTVAR	ODDĚLENÍ	STUPEŇ
65	MESOZOIKUM	KŘÍDA	SVRCHNÍ	maastricht
				campan
				santon
				coniac
				turon
				cenoman
			SPODNÍ	alb
				apt
				barrem
				hauteriv
				valangin
144				berrias
		JURA	SVRCHNÍ (MALM)	tithon
				kimmeridž
				oxford
			STŘEDNÍ (DOGGER)	callov
				bathon
				bajok
				aalen
			SPODNÍ (LIAS)	toark
				pliensbach
				sinemur
208				hettang
		TRIAS	SVRCHNÍ	rhaet
				nor
				carn
			STŘEDNÍ	ladin
				anis
245			SPODNÍ	scyth (werfen)

Chronostratigrafie



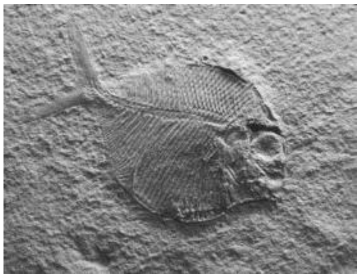


Typické sedimentární facie

Trias – („trojné“ dělení útvaru – „trojice“)
Buntsandstein (pestrý pískovec), **Muschelkalk** (lastrunatý vápenec),
Keuper (pestrý slín)
germánský vývoj, **alpinský vývoj** – vindelický práh
Burgundská a moravská „brána“

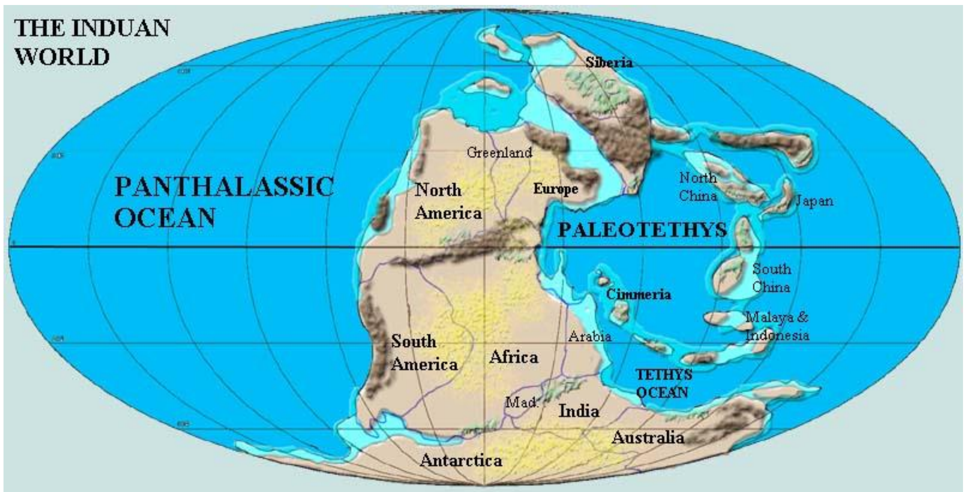
Jura – pohoří Jura
starokimereská fáze
mladokimerská fáze
černá, hnědá a bílá jura
Calcare Rosso Ammonitico, radiolarity, solnhofenské vápence,
holzmadenské posidoniové břidlice

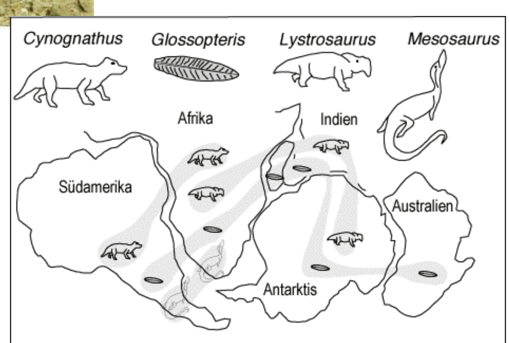
Křída – psací křída (pazourky)
spongolity, urgonská facie, opuky, bauxity



Paleogeografie a tektonické procesy

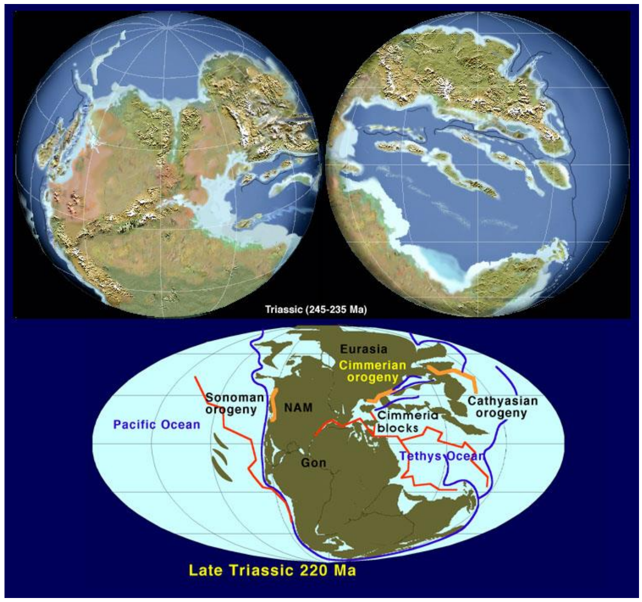
Spodní trias: Pangea (Lystrosaurus), aridní klima, Paleotethys, (neo-)Tethys, Panthalassa, Kimerské terány

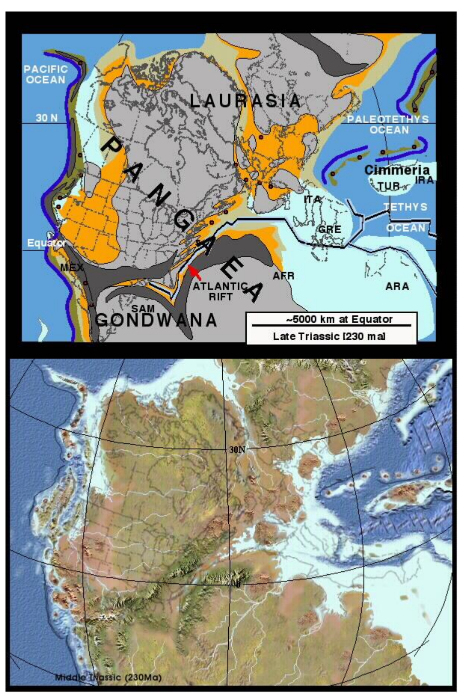




Verbreitung von Fossilien über die südlichen Kontinente von Pangaea

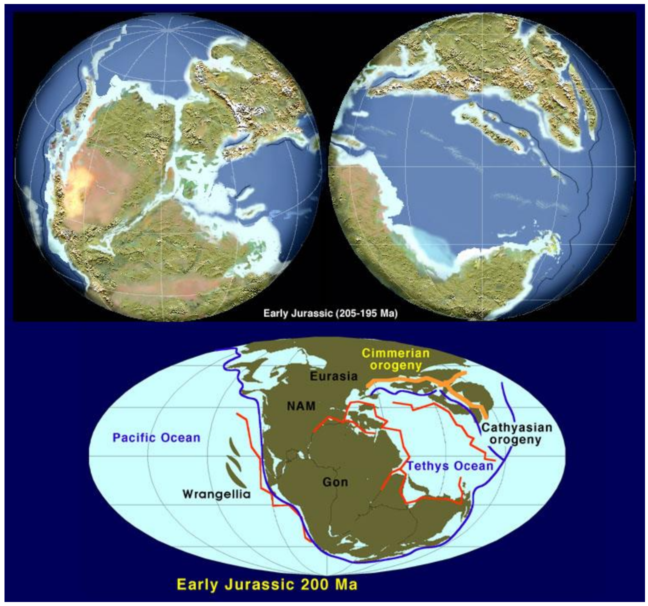
Svrchní trias: Pangea, uzavírání Paleotethys – kimerská orogeneze (Střední Asie), (neo-)Tethys, Panthalassa, sonomská orogeneze (Sev. Amerika), počátek otevírání centrálního Atlantiku



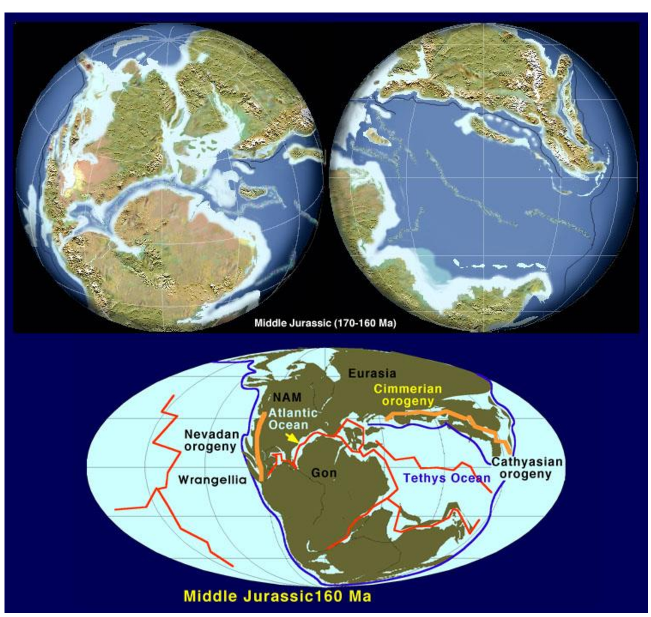


Otevírání centrálního Atlantiku (bývalý variský orogén)

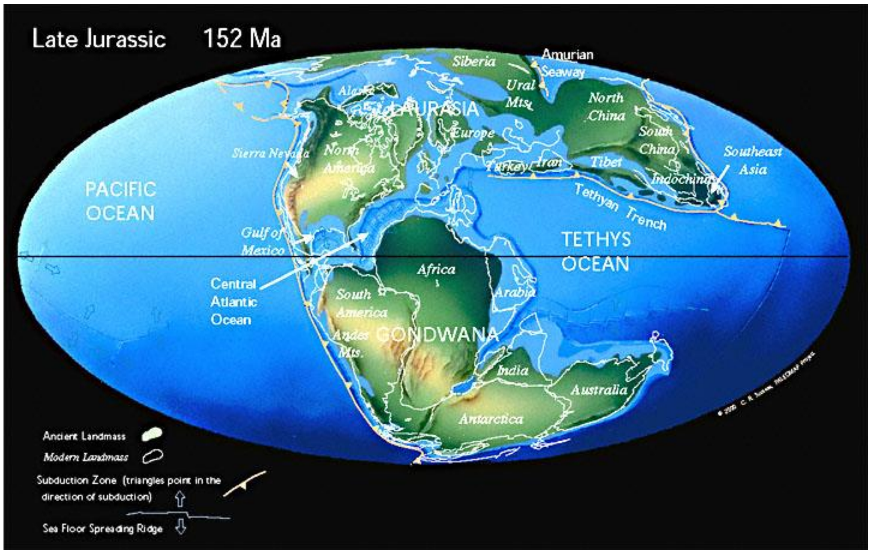
Spodní jura: otevírání (rifting) Tethys směrem k západu (jižní Evropa), pokračování kimerské orogeneze



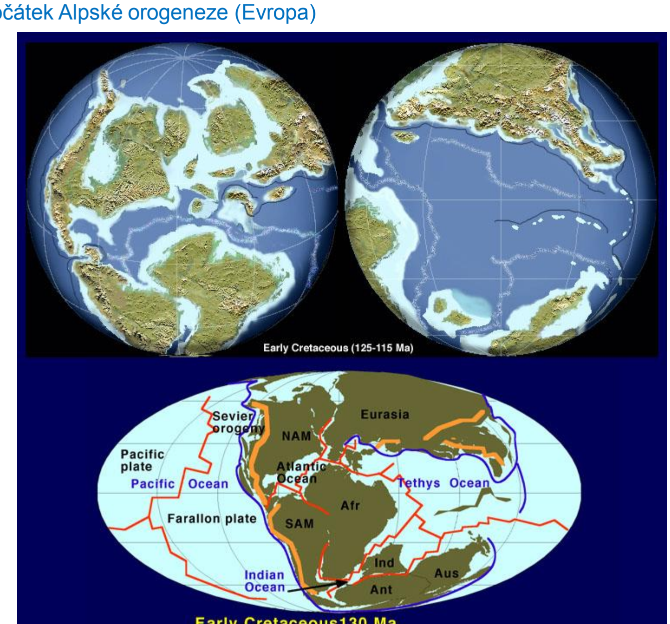
Střední jura: otevření centrálního Atlantiku, dozvuky kimerské orogeneze, nevadská orogeneze (Sev.Amerika)



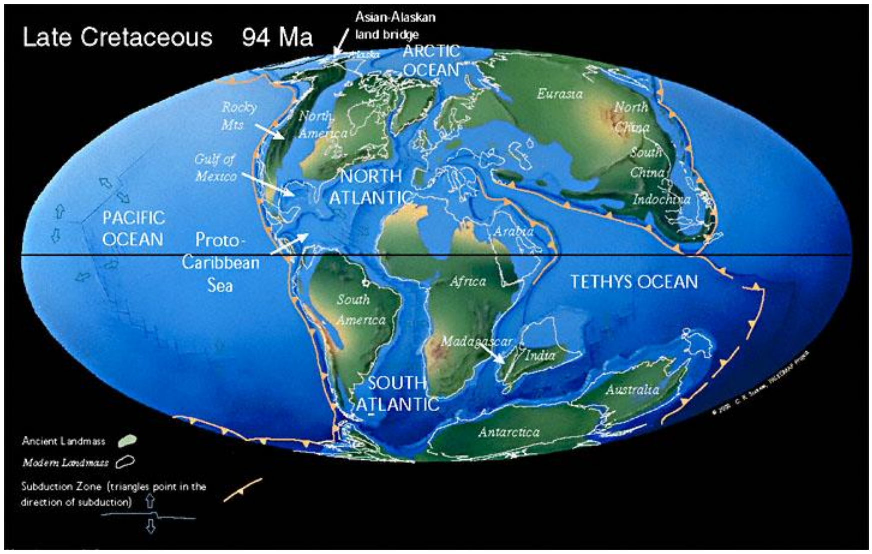
Svrchní jura: otevření centrálního Atlantiku a Mexického zálivu, počátek štěpní západní Gondwany (Afrika, jižní Amerika, Madagaskar) a východní Gondwany (Indie, Austrálie, Antarktida, Nová Guinea)



Spodní křída: východní Gondwana zcela oddělena od západní, otevírání jižního a severního Atlantiku, oddělení Indie od východní Gondwany, Sevierská orogeneze (Sev. Amerika), počátek Alpské orogeneze (Evropa)

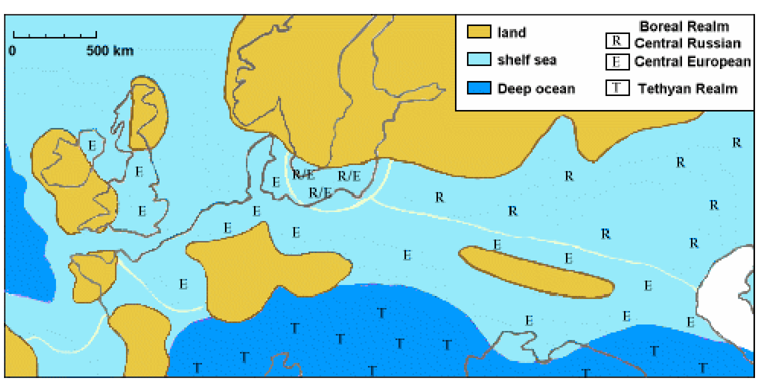


Svrchní křída: zcela otevřený jižní Atlantik, Indický subkontinent (Indický oceán), mořský průliv Amerického středozápadu, západní Evropa zalita mořem (eustatické maximum 1. řádu)



Faunistické bioprovincie (jura – křída)

Tethydní říše – **Diceras**, **Nerinea** in Jurrasic, other rudists, Nerinea and **Globotruncana** in Cretaceous.



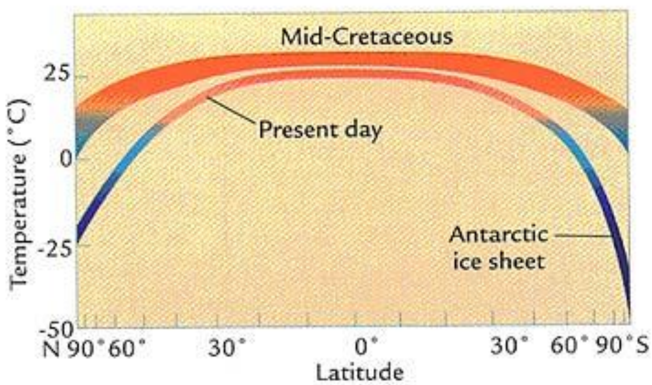
Boreální říše – clastic sedimenst, Virgatites, **Cylindroteuthis**, **Bositra** in Jurrasic, **Globigerina** in Cretaceous.

Klima

Trias – aridní, podobně jako v permu

Jura - teplejší klima než dnes, termofilní cykasy dosahují až 60 stupňů severní šířky, Termofilní flóra na Gondwaně a na Sibiři.

Křída – teplé humidní klima, subtropická vegetace až 70 stupňů severní šířky. Konec křídy - ochlazení



Alpinská orogeneze

Uzavírání oceánů mezi Gondwanou a Eurasií.

7 fází
1) Labinská – carn
2) starokimerská – trias/jura
3) mladokimerská – jura/křída
4) austrijská – křída před cenomanem
5) mediteranní – křída před senonem
6) subhercynská – senon
7) laramijská – křída/terciér

Kimerská orogeneze – východní Tethys

During Triassic to early Cretaceous divergent movements predominated between Africa and Epivariscan platform of Europe. Late Cretaceous – convergence, main phases of folding

Mesozoic flora

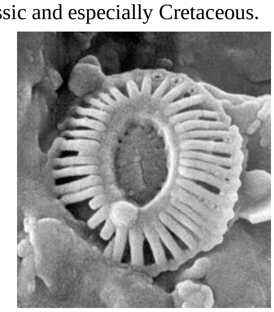
Nižší rostliny - řasy

Triassic – rock-forming and stratigraphic role of **Dasycladaceans**. **Wetterstein Limestones**.

Red algae – the beginning of Mesoczoic still **Solenoporacea**, maximal development in Jurassic, in Cretaceous dominance of **Corallinacea**.

In Jurassic and especially Cretaceous diversification of marine microflora. In **Jurrassic** – **explosive evolution of Dinoflagellates**, another explosive phase in Cretaceous. **Cretaceous last expansion of acritarchs**. Growing role of **calcareous nanoplankton** in Jurassic and especially Cretaceous.

Chalk – epicontinental seas, 200-300m depth



Expansion of **Diatomaceae** in Cretaceous, together with dinoflagellates and calcareous nannoplankton Main photosynthetic group.

Fytoplankton

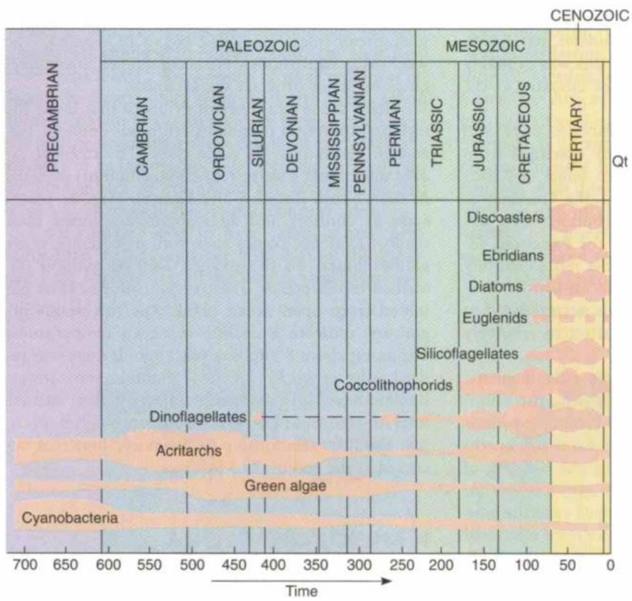
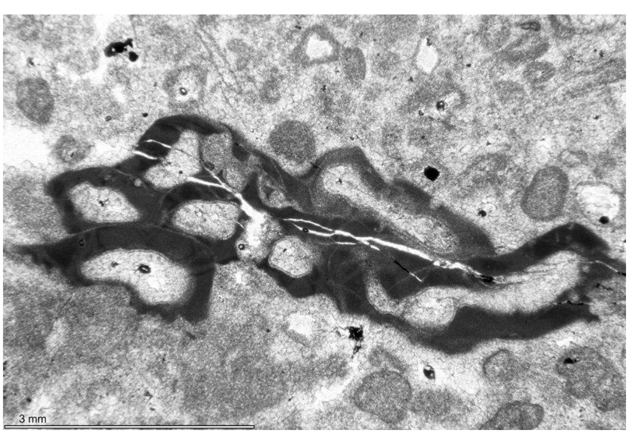


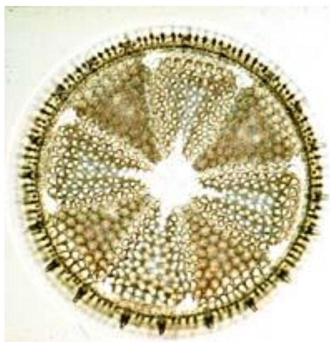
FIGURE 12–2 Geologic distribution and abundances of phytoplankton. *(From Tappan, H., and Leoblich, A. R., Jr. 1970.* Geol. Soc. Am. Special Paper *127:257.*

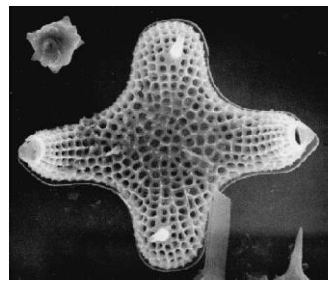
Triassic – rock-forming **Tubiphytes**, rock-forming and stratigraphic role of Dasycladaceans. **Wetterstein Limestones**.

Tubiphytes



Bacillariophyta (rozsivky, diatomy)





Vyšší rostliny

Mesofytikum – dominance of gymnosperms.

Trias – cycasy, jehličnany, a ginkgovité.

Cykasy – similar to palms, their dominance up to Jurassic. In Jurassic expansion of related group bennetites (extinct in late Cretaceous). Since early Cretaceous retreat.

Jehličnany – in Triassic still Voltziales (**Voltzia**). During **Triassic nearly all modern families** appear. Expansion in Jurassic, in early Cretaceous dominant group of gymnosperms. Since late Cretaceous higher latitudes,

Ginkgovité – abundant especially in Jurrasic-early Cretaceous.Today only Ginkgo biloba.

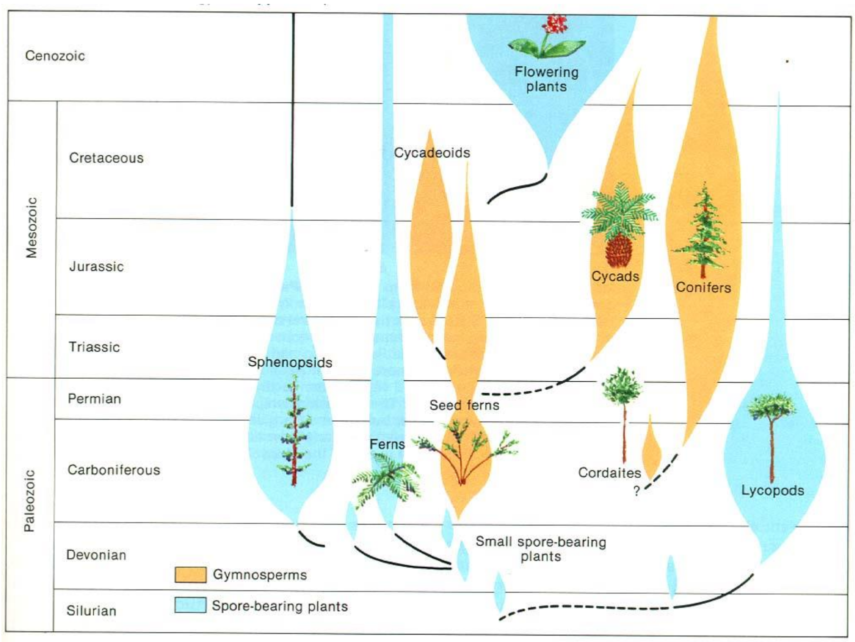
In Triassic **still abundant ferns and lycopods**.

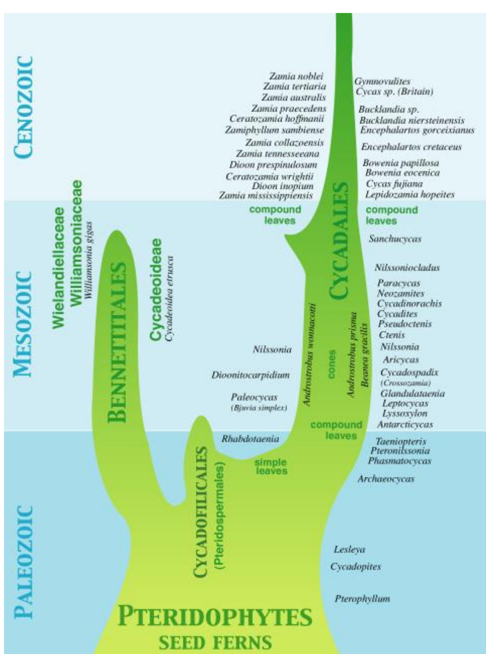
První krytosemenné rostliny – latest Jurassic., in early Cretaceous quick diversification, since middle Cretaceous dominant flora - **kenofytikum**.

Great advantages – short reproduction cycle, polination by insects

Absence of grasses and savana, prairie and meadow biotopes.

Czech Cenomanian – subtropic genera as **Magnolia, Laurus, Platanus, Ficus**,





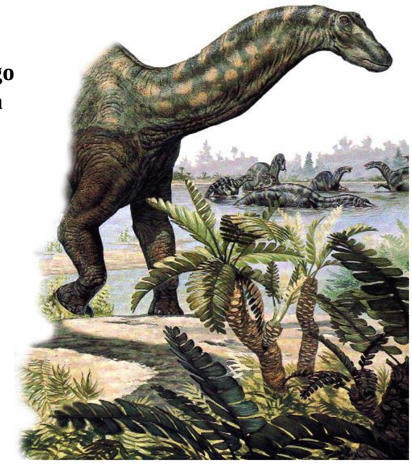
Cykasy:

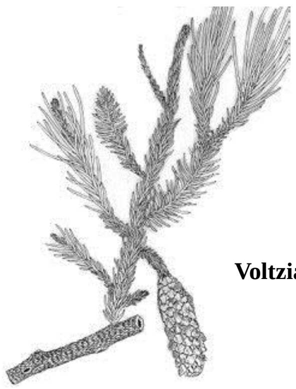
Nilssonia

Cycadites

Leptocycas

Ginkgo biloba





Voltzia

Nejstarší fosílie kvetoucích rostlin

Archaefructus liaoningensis

*140-million-year-old fossil from northeast China. The leafy,seed-containing pods (carpels) are the defining characteristic of angiosperms ("seeds in vessels").

*Petals are apparently absent, but leaf-like structures subtending each fruiting axis define them as flowers.

Enlarged view of the carpels (each is about 1 mm long) showing seeds in carpel (Sun, Dilcher, Zheng & Zhou. 1998. Science 282:1692).

FAUNA

Mlži

Mlži – dominantní skupina mořského bentosu
Claraia claraii (trias)
Halobia (jura), pseudoplanktonní, „vláknová mikrofacie“
Rudisti (*Diceras*, *Vaccinites*): útesotvorní mlži, „urgonská facie“ (Orgon)
Inoceramus / *Mytiloides* (křída)

Claraia

Diceras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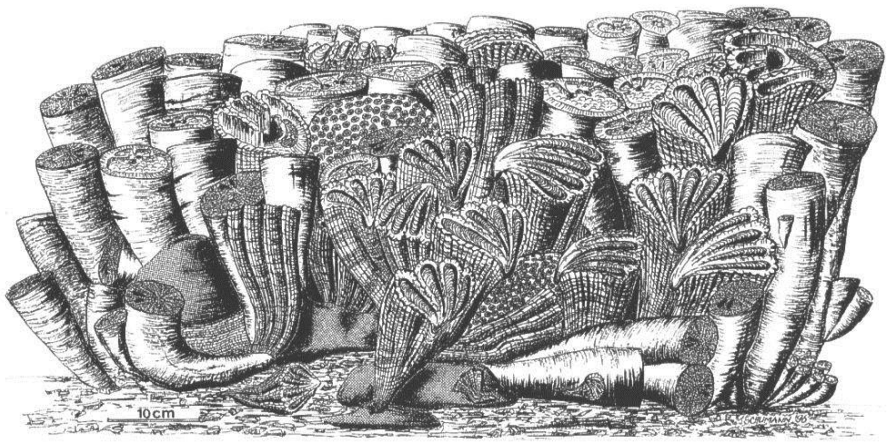
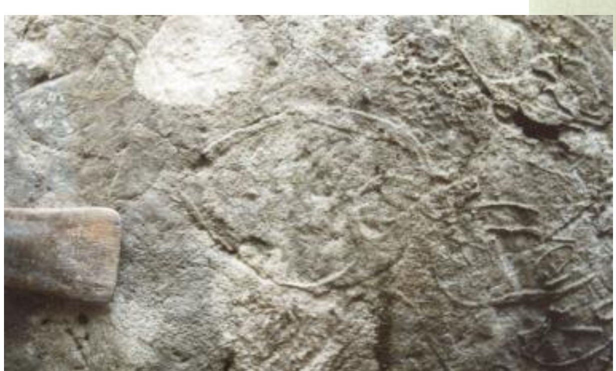
DES ALPILLES

Biostrome of *Vaccinites vesiculosus* (Woodward, 1855); Campanian of Saiwan, Oman (from Schumann & Steuber 1997)



Association of *Vaccinites*, *Torreites*, corals and stromatoporoids; Campanian of Saiwan (from

***Inoceramus* sp.**



***Megalodon* sp.**

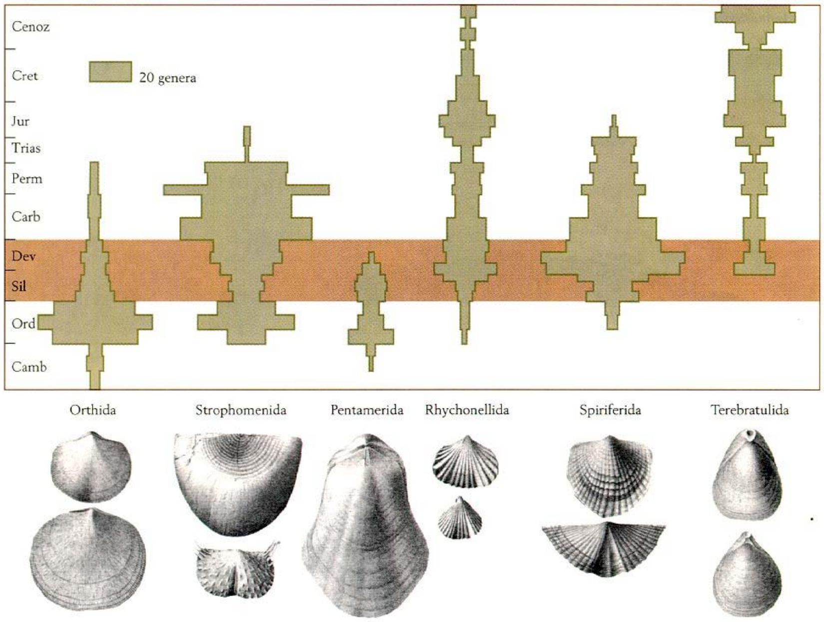
Porifera

expansion in Mesozoic.
Reef builders in Triassic and Jurassic – siliceous **desmospongiids**.
Cretaceous – great **rock-forming** role. **Spongolites**, arenaceous marls.

Gastropoda – typical genus for Tethyan Realm **Nerinea**. In Cretaceous gastropos associations obtain Caenozoic charcter.

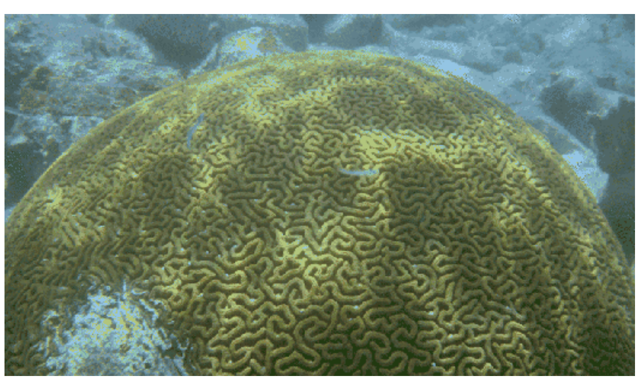
Echinoderms – increasing representation of **echinoids**. In Jurassic established themselves especially irregular echinoids. Crinoids nearly extinct after P/Tr extinction. Slow diversification in Triassic, In **Jurassic rock-forming role**. In Cretaceous retreat.

Brachipoda – Triassic small diversification, especially **rhynchonellids** and **terebratulids**.
Since Triassic retreat.



Korálnatci

Scleractinia (hexacoralla)
útesotvorné

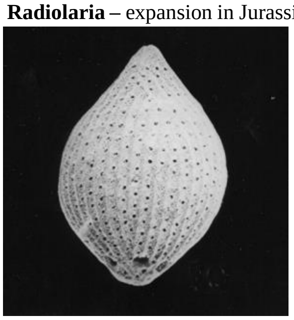


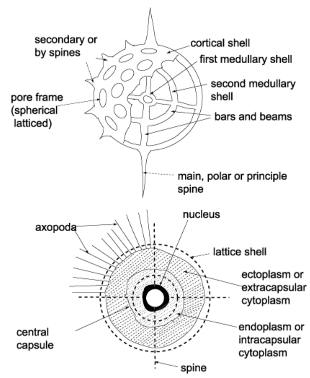
Scleractinian ("hard-rayed") corals first appeared in the Middle Triassic and refilled the ecological niche once held by tabulate and rugose corals. They are probably not closely related to the extinct tabulate or rugose corals, and probably arose independently from a sea anemone-like ancestor. Their pattern of septa differs markedly from that of the Rugosa, being basically six-rayed. For this reason, scleractinians are sometimes referred to as hexacorals. First deep water, since malm shallow water and reef forming.

Foraminifery – extinction. Triassic only benthonic. **Since Jurassic planktonic**, expansion of bethic forms to bathyal zone. Radiation of planktonic forms in Cretaceous. **Globotruncanas**, 20 foraminiferal zones.

Globotruncana

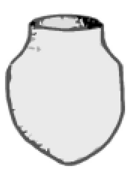
Radiolaria – expansion in Jurassic, Spumellaria.





Diagrammatic cross-sections of spumullarian radiolaria.

Kalpionely (Infusoria) – biostraigraphic and rock-forming role in late Jurassic-early Cretaceous. Pelagic limestones of Tethyan province. **Calpionella**.



Členovci

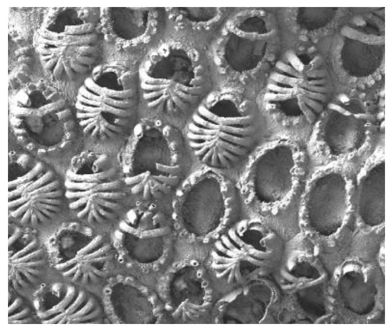
Malacostraca - **Crabs, shrimps, beach hoppers, lobsters, etc**

Ostracoda – low diversity after end Triassic extinction, , greter role in late Cretaceous.

Insecta – coevolution with angiosperms, bees, ants, mosquitos

Bryozoa –End of Triassic – **last Stenolemata** disappear (Cryptostomata, Treptostomata). Diversification of **Cyclostomata** in Jurassic, end Jurassic **first Cheilostomata**

Cheilostome bryozoan



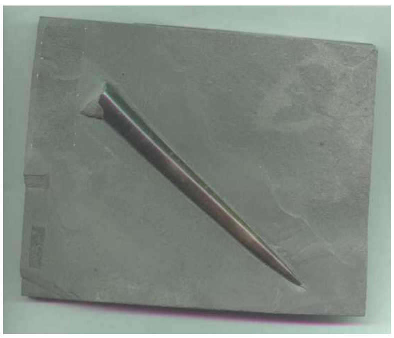
Ammonoidea

Nearly extincy during P/tr extinction event. 2 genera survive, **adaptive radiation of Ceratitida** in early Triassic. **End Triassic extinction**, nearly all ammonite genera. Since beginning of Jurassic new **adaptive radiation of Ammonitida**. 70 ammonite zones, ammonite limestones (Calcare ammonitico rosso), Aptych limestones. End Jurassic extinction.
Cretaceous – last expansion of ammonites. Also gigantic forms as **Parapachydiscus** or **Lewesiceras**. **Heteromorph species**

Lewesiceras peramplum

Nautiloidea - ústup. End Triassic **extinction of orthocers**.

Belemniti -appear in late Paleozoic. Expansion in Jurassic and Cretaceous, C/Ter boundary – most of the extinct.



Conodonta – end Triassic extinction.

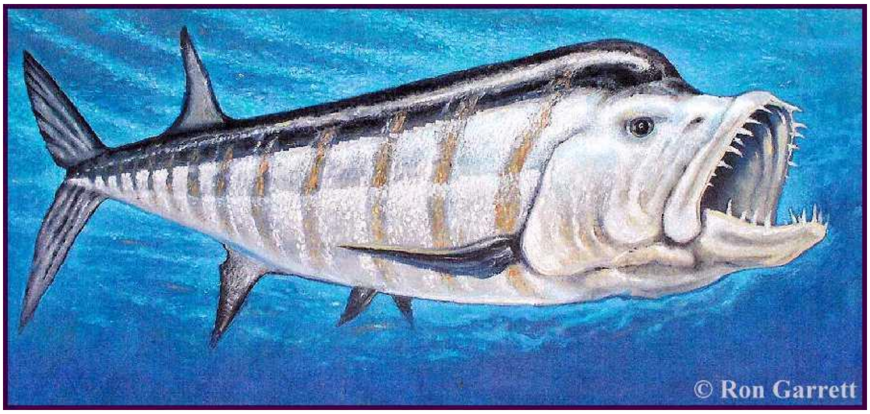
Actinopterygii

In Triassic Holostei domination.. In Jurassic expansion of Teleostei which become the dominant Fish group. Other groups of actinopterygii retreat. In Cretaceous e.g. Paleoniscida become extinct. **Xiphactinus**

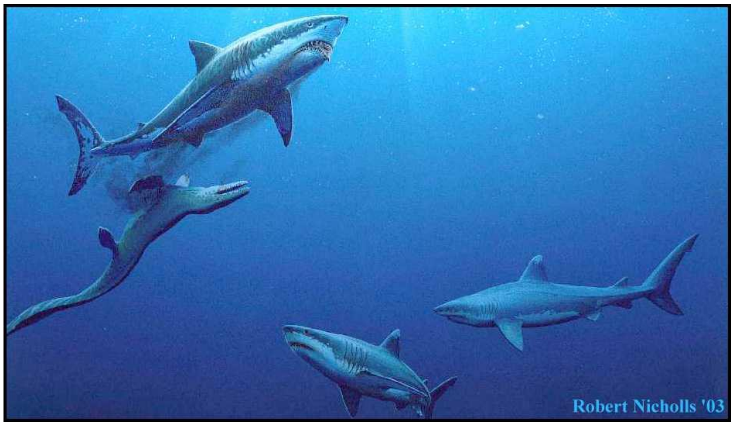
Actinopterygii
- Chondrostei – dominat late Paleozoic fish group
- Holostei- dominant in Triassic
- Teleostei- dominant since Jurrasic

Crossopterygii, Dipnoi – Triassic last system in which higher representation Today – „living fossils“

Příčnoústí – In Triassic important hybodonts, nutton-like teeth, crushing of bivalve test. In Jurassic expansion. And modern families appear. In Cretaceous 12 of 16 recent families. **Cretoxyrhina**



***Xiphactinus audax*, (teleostei) or as it is more commonly called, the "Bulldog Fish", was a species of very large predatory fish that lived in the ocean during the Late Cretaceous.**
18 to 20 feet, and some 'giant vertebrae' from marine deposits in Arkansas indicate that some individuals that were even larger.



The large shark at the top is *Cretoxyrhina mantelli*, while the two smaller sharks at lower right waiting their turn are *Squalicorax falcatus*.

Amphibia – in Triassic still Paleozoic group **Temnospondyli**, retreat and end Triassic extinction, reduced survival till mid Jurassic. New modern groups appear in Triassic.
First frogs – **Triadobatrachus massinoti**, **Caudata**. Gradual entry of other modern groups in Jurassic and Cretaceous.

Plazi (Reptilia)

Reptile Subclasses:
1 – **Anapsida**
Cotylosauria- stem reptiles
Chelonia - turtles & tortoises
•unchanged for about 175 million years
•identified by bony dermal plates to which ribs & trunk vertebrae are fused
2 - **Lepidosauria**
Rhynchocephalia (haterie) - only living representative is the Tuatara
Squamata (šupinatí) - ještěři, gekoni, & hadi
3 -**Archosauria**
Thecodontia (jamkozubí) – stem archosaurs
Pterosauria (ptakoještěři)
Saurischia (plazopánevní) - 2 major groups: sauropods & theropods — Dinosauria
Ornithischia (ptakopánevní)
Crocodilia (krokodýli)
4 - **Euryapsida** - marine reptiles, includes the plesiosaurs & ichtyosaurs

Euryapsida

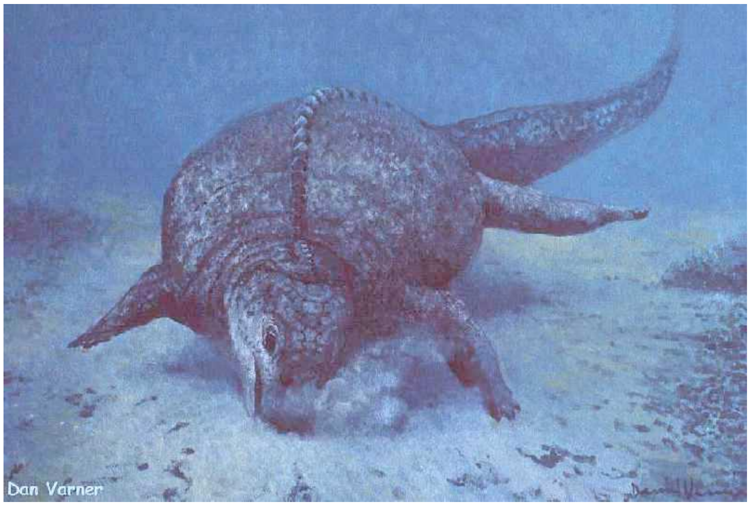
Euryapsids include ***Ichthyopterygia*** and ***Sauropterygia***

Sauropterygia – Notosauria
Placodontia
Ichtyosauria

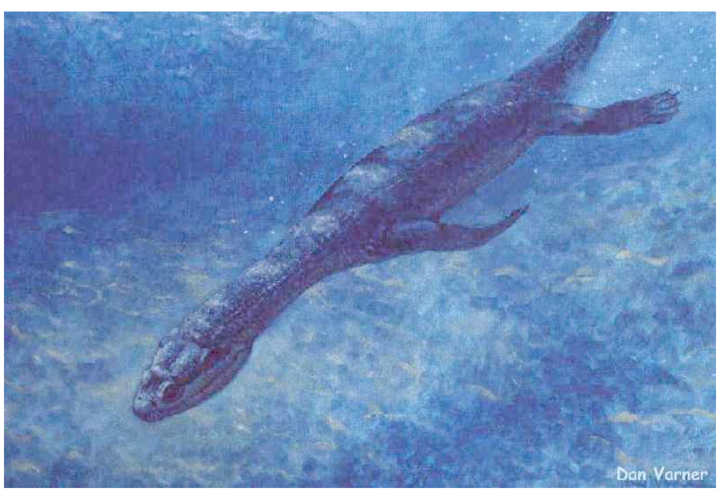
Ichthyosaurs and plesiosaurs had inhabited the oceans since the Triassic, evolving into many diverse forms and surviving several major extinction events.

For unknown reasons, **ichthyosaurs** declined significantly in early Cretaceous and are thought to have been extinct by the time that the earliest **mosasaurs** re-entered the water**.**

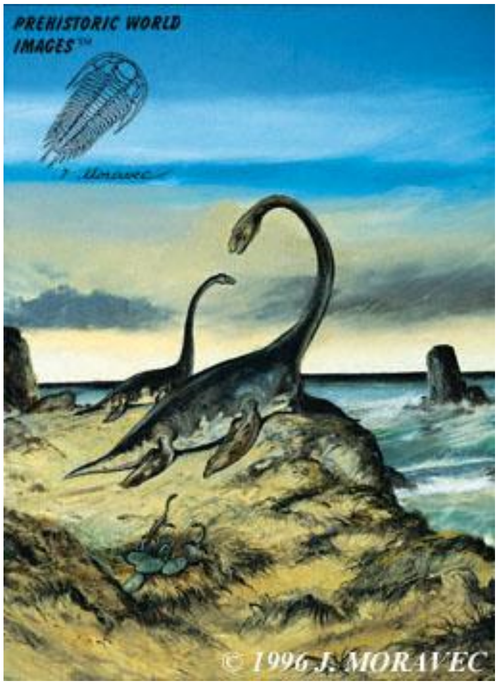
Plesiosaurs were also less numerous in the late Cretaceous than during the Jurassic, and had evolved into some very specialized forms like the **long-necked *Elasmosaurus*.** Even the **short-necked plesiosaurs (pliosaurs)** were much smaller than their Jurassic cousin, *Liopleurodon*, and an early Cretaceous relative, *Kronosaurus*. It is possible that both the ichthyosaurs and the plesiosaurs were losing the evolutionary battle of "who eats who" to faster, larger and more advanced varieties of fish such as *Xiphactinus* and the giant Ginsu sharks (*Cretoxyrhina mantelli*). Several other groups of reptiles, including marine **crocodiles**, teleosaurs, placodonts and turtles had also enjoyed limited successes in the marine environment, but none approached the world-wide domination that mosasaurs would attain in the late Cretaceous.



Placodus, a placodont from the early to middle Triassic of Europe grubs for clams and other shellfish in the mud of a near-shore sea bottom. While placodonts fed in the ocean, they probably spent a large portion of their lives on land



A **nothosaur** (early to late Triassic) prowls the shallow sea for food. These semi-marine lizards reached lengths of about 3 meters. Their remains are found in many places around the world, including China, Russia, Germany, the Netherlands and North Africa. Instead of paddles, Nothosaurs had webs between their long toes



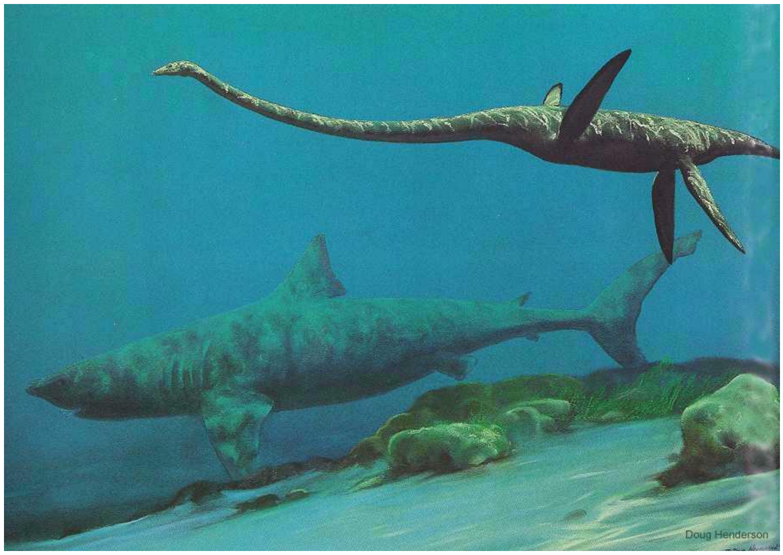
•**Plesiosauroids** - had long, snake-like necks, tiny heads, and wide bodies. They ate small sea creatures, probably using their long necks like a snake to catch their prey. They included:

•**Plesiosaurus** - 7.6 feet (2.3 m) long - with a long neck, 4 wide, paddle-shaped flippers, and a tapered body. From England and Germany during the early Jurassic period.
•Muraenosaurus - 20 feet (6 m) long - with a very long neck, and a wide body. From England and France during the late Jurassic period.
•Woolungosaurus - 26-33 feet (8-10 m) long - with a very long neck. From Queensland, Australia, during the early Cretaceous period, about 110 million years ago.
•**Elasmosaurus** - 46 feet (14 m) long with an extremely long neck that was up to half of its length. It had and had 71 vertebrae, 28 of which were in its neck. It had four very long paddle-like flippers, and a short, pointed tail. From Japan and Kansas, USA, during the late Cretaceous period.

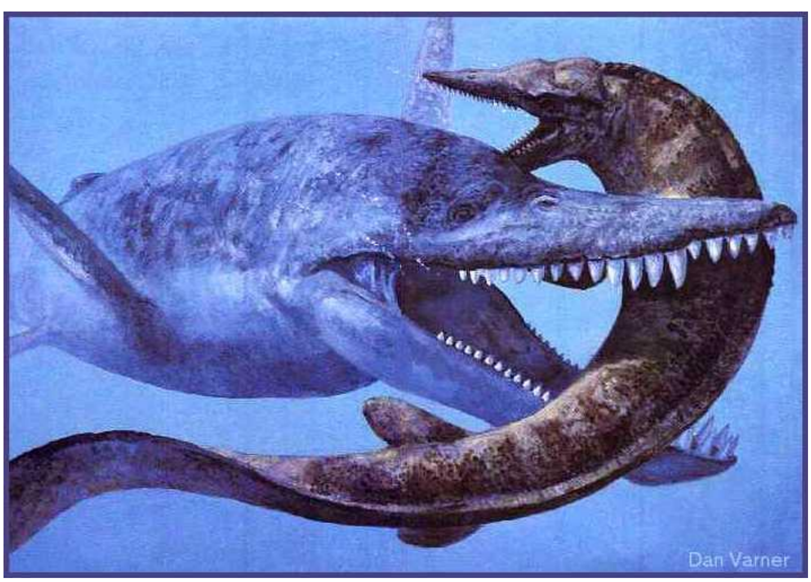
•¨

•**Pliosauroids** - had large heads with very strong jaws, short necks, and resembled modern-day whales. They ate larger sea creatures. They included:

•**Kronosaurus** - 30 feet (9 m) long with a short neck and huge head and jaws. The flat-topped head was up to 9 feet (2.7 m) long, about 1/4 of the entire length of the body. From Queensland, Australia during the early Cretaceous period.

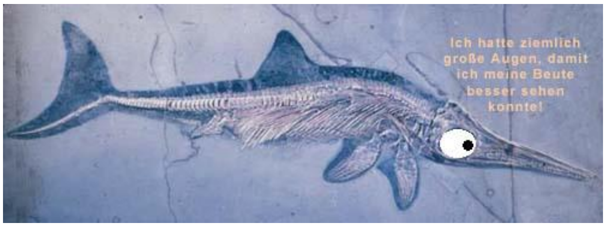


The plesiosaurs, including this long-necked ***Elasmosaurus***, used their rigid, bony paddles like wings to 'fly' through the water. This half-grown juvenile is swimming rather close to a huge (18') shark called ***Cretoxyrhina mantelli***. Whether or not these sharks attacked living prey or only scavenged the carcasses of the dead is not known for certain, but the marks made by their large, sharp teeth have been found on mosasaur and plesiosaur bones.

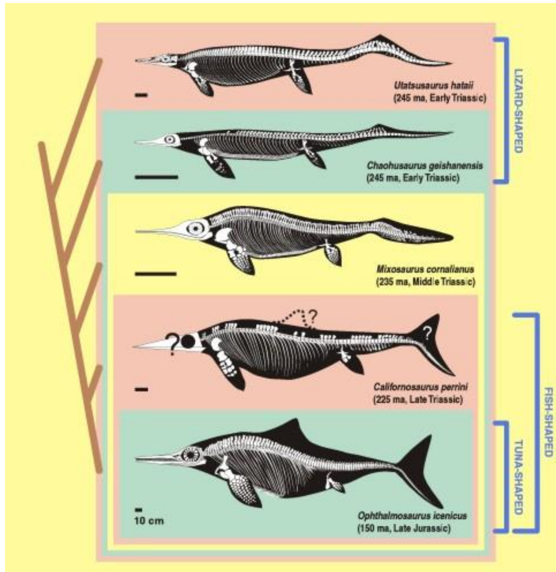


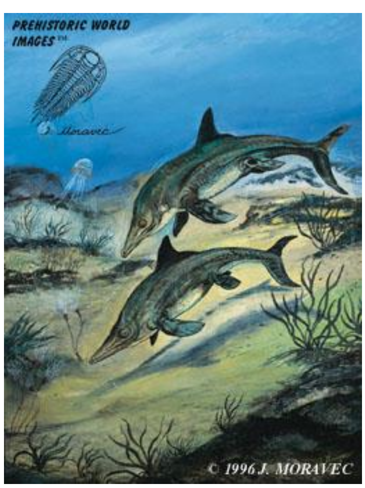
This picture shows what happens when the hunter becomes the hunted; a giant pliosaur **Kronosaurus attacks a juvenile mosasaur.** Even though mosasaurs were top predators, their young were often preyed upon by sharks, large fish, pliosaurs and even other species of mosasaurs. Life could be short for the unwary

Ichtyosaurs- maximal expansion in Jurassic, Holzmaden. **Stenopterygius** abundant. 11m **Letopterygius**. Rare in Cretaceous, extinct at the end.



Ichthyosaurs diversified very quickly once they appeared. Several different body plans emerged in the Early and Middle Triassic. But, if you simplify the matter, you can see that there was a **general transition from lizard-shaped body plan to fish-shaped one through the evolution** of ichthyosaurs, as in the figure below**.**





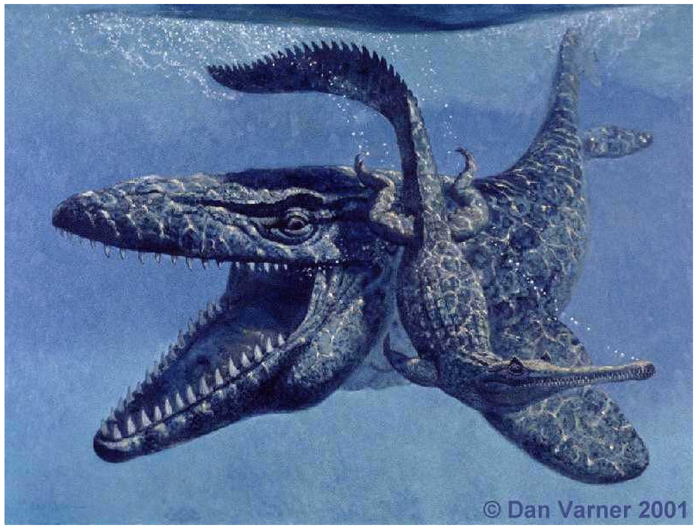
Mosasauři

The early ancestors of mosasaurs probably fed in the ocean and returned to land much like the marine iguanas that are found today in the Galapagos Islands. Over a relatively short period of time, however, these ancestral mosasaurs became larger and more specialized, evolving rapidly into several genera of highly successful predators. By the beginning of **Coniacian time** (about **90 million years ago** - mya), there were **three major genera:**

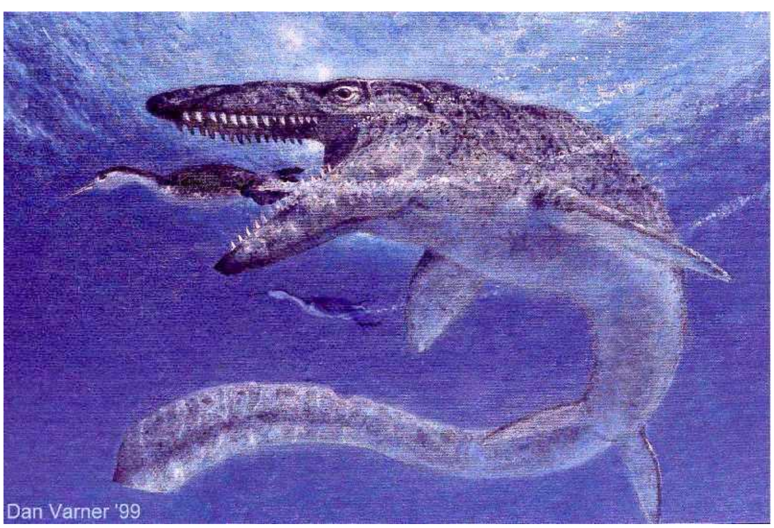
Tylosaurus	10 meters (30 feet) – 14 m
Platecarpus	8 meters (24 feet).
***Clidastes* less than**	5 meters in length
Hainosaurus bernardi	17 m

living in the Western Interior Seaway. There was no doubt who were the biggest and baddest predators in the oceans 70 million years ago.

The open jaws of the shark **Cretoxyrhina mantelli**,hit the **mosasaur** on the right side, just behind the rib cage, and the impact lifted the wounded animal almost completely out of the water.

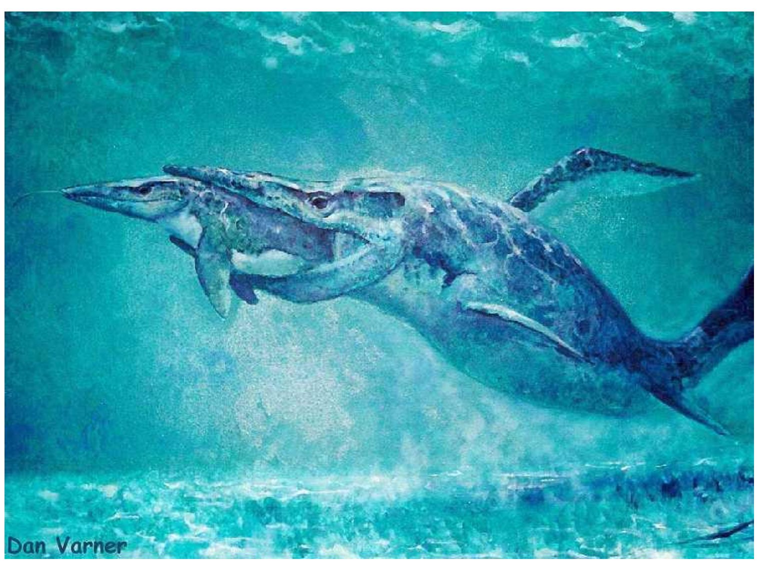


Here a ***Mosasaurus hoffmanni*** just misses the mark in an attack on the marine crocodile**, *Thoracosaurus*,**

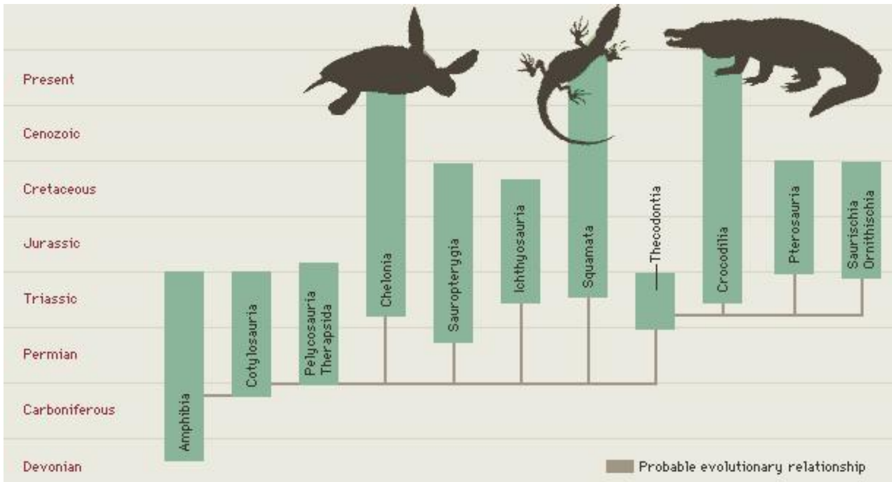


the little swimming birds (***Hesperornis***) are about 5 feet long and the ***Tylosaurus*** ... well, it's huge. Modeled after the largest specimen on exhibit (The Bunker Tylosaur), this beast was at least 45 feet long and had a skull that was 6 feet in length.

This picture shows an attack by a very large (30'+) mosasaur called ***Tylosaurus proriger*** on a much smaller ***Platecarpus* mosasaur**. Tylosaurs occasionally killed and ate other species of mosasaurs but there is no evidence to show that any of the mosasaurs were cannibalistic toward their own species.



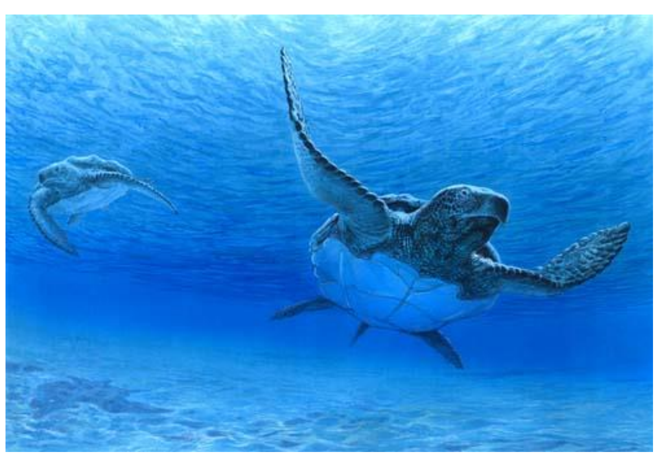
Here a large ***Tylosaurus*** is about to make lunch of a smaller mosasaur called ***Halisaurus sternbergi*.** Like their modern relatives, the snakes, mosasaurs were capable of swallowing large prey whole because of the unique design of their skull and very flexible lower jaws.



Land Reptiles

Cotylosaurs – end Triassic extinction

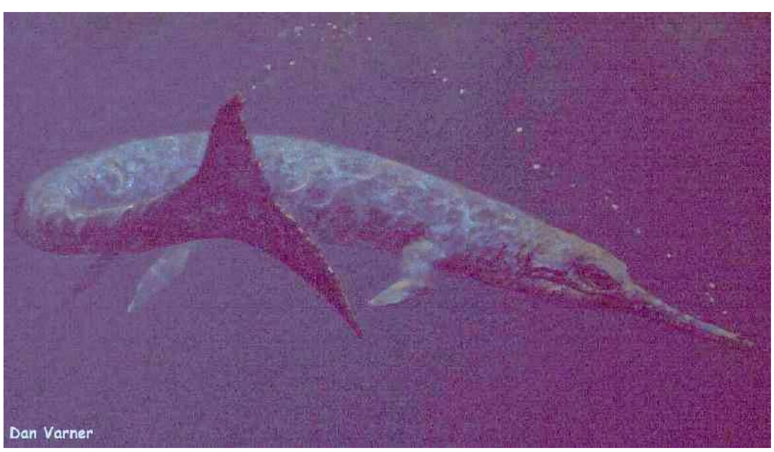
Chelonia – originally terrestrial animals, late Jurassic transition tomarine environment.
Cretaceous – 4m **Archelon**



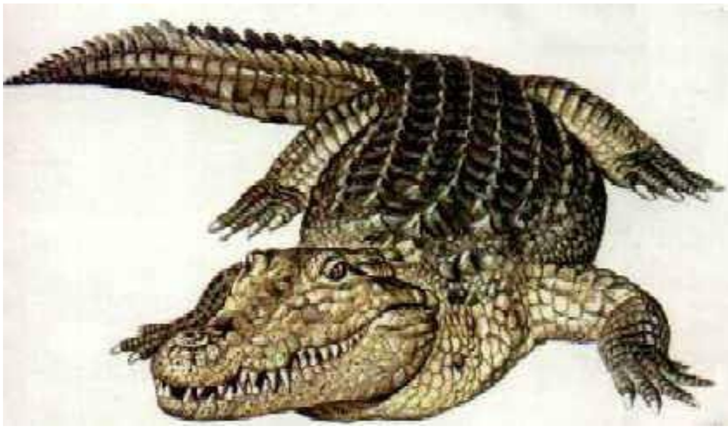
Lepidosauria – radiation at the beginning of Triassic, Small lizard-like reptiles. Predecessors of thecodonts (Permian) and Squamata (Triassic)

Thecodonta – wide expansion in early and middle Triassic. End Triassic extinction (dinosaurs?)

Crocodilia – Triassic, thecodont predecessors. Originally land animals, secondary to water environment. Great expansion in Jurassic, mostly in seas. In Cretaceous gigantic forms as 15m **Phobosuchus**.



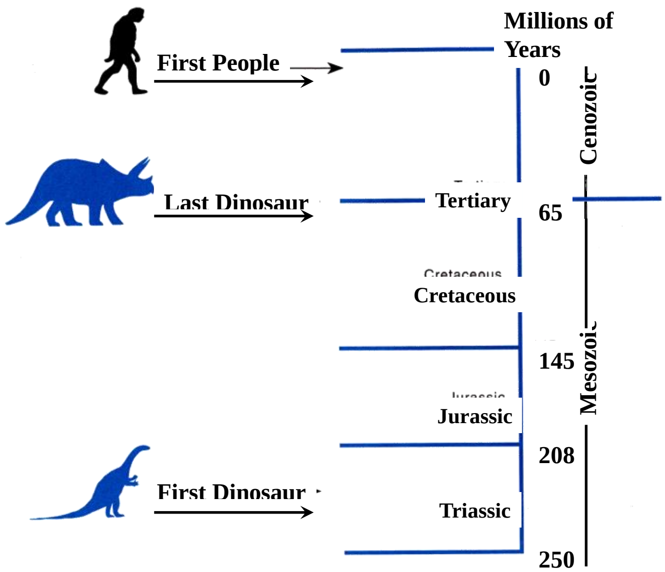
An early and very 'fish-like' crocodile ***Geosaurus*** swims in the shallow seas covering Germany in the Middle to Late Jurassic. Although not closely related to the ichthyosaurs, the tails of member of the Metriorhynch family were adapted for swimming in the same way, even to the noticeable down bend in the posterior caudal vertebrae.



Phobosuchus

Dinosauři

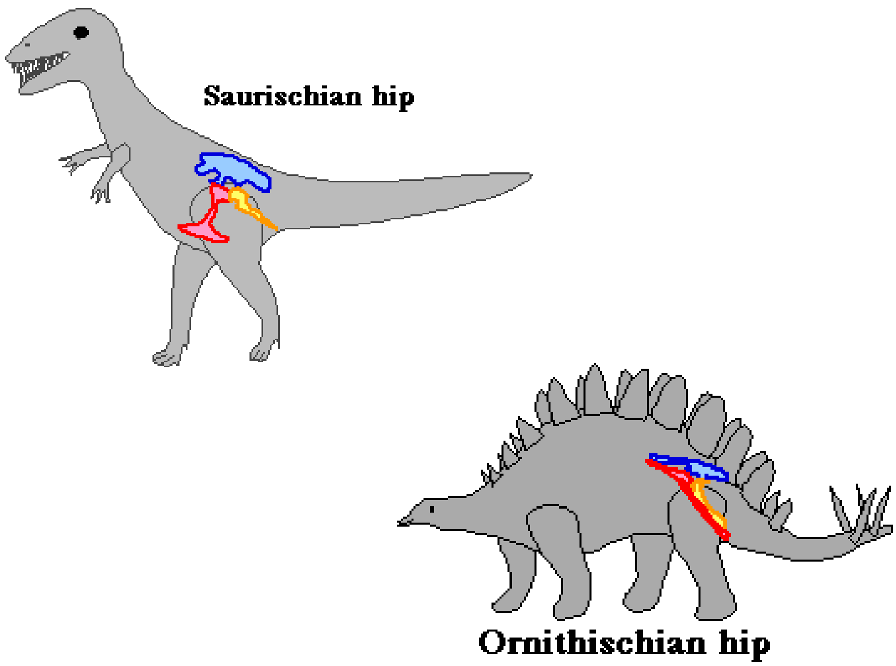
When did dinosaurs live?

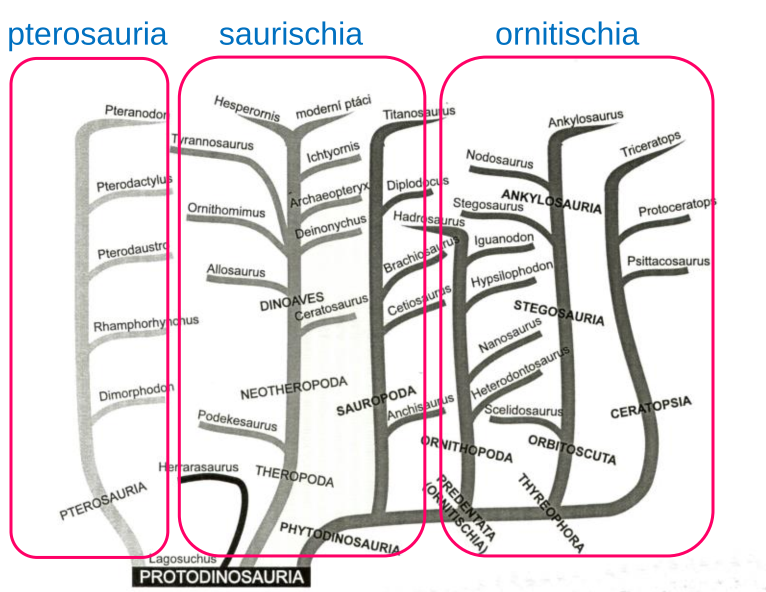


What are dinosaurs?

- Technically: no such thing as dinosaurs
- Classification:
  - Class – Reptilia (reptiles)
  - Order – Archosauria
  - Suborders
    - Saurischia – lizard hips
    - Ornithischia – bird hips

Dinosaurs in popular sense

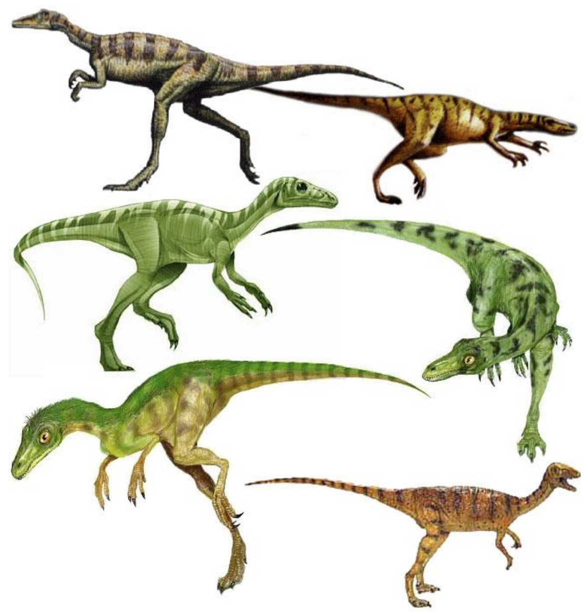




Obr. 71. Schematické znázornění evoluce dinosaurů (zjednodušeno podle Bakker, 1986).

Protodinosauria

Eoraptor



Who were the Theropods

- Contained all of the meat eating dinosaurs of the Mesozoic
- Also contained some plant eaters having primitive characteristics

Celurosauria and Carnosauria

Celurosauria

Coelophysis

Typical Coelurosauria: Saltopus

Coeleurosaurs

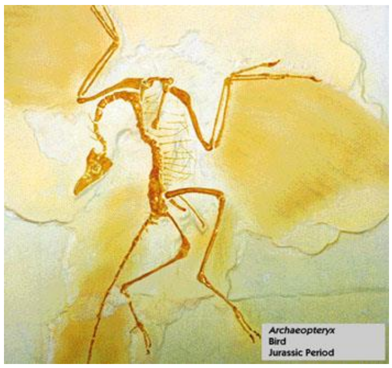
- Very successful in Mesozoic
- Coelurosauria

Velociraptor (Jurassic Park)

Velociraptor ?

Troodon

Archaeopteryx

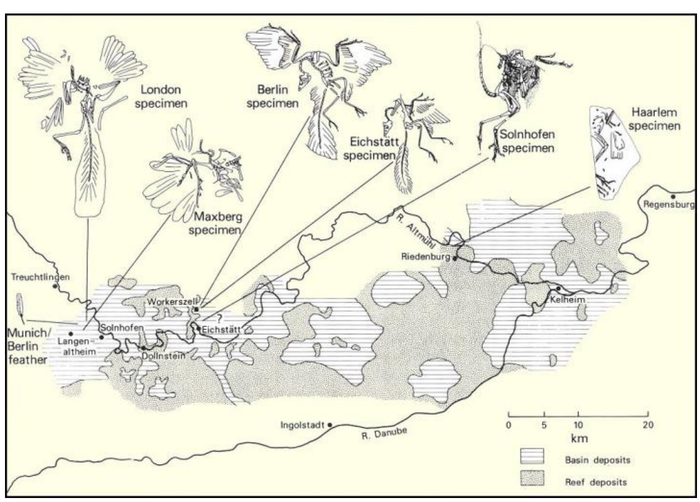


Fossil

Maybe…?

Where are Archaeopteryx found?

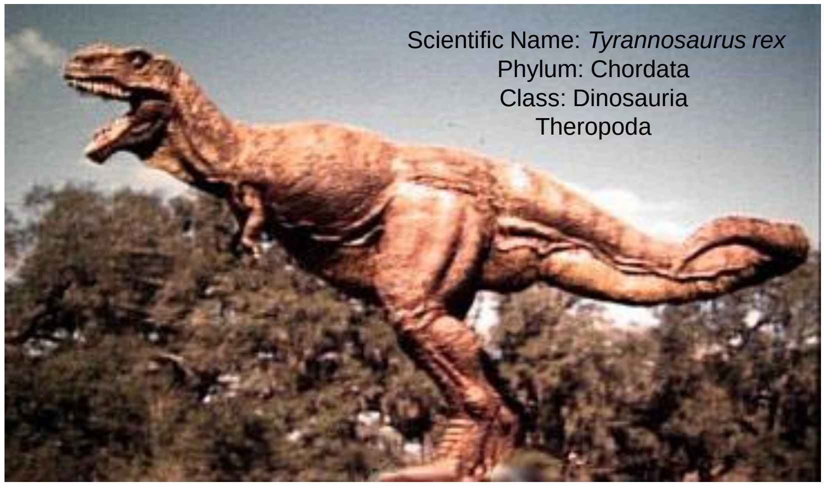
Mostly in Germany



Carnosauria

Allosaurus

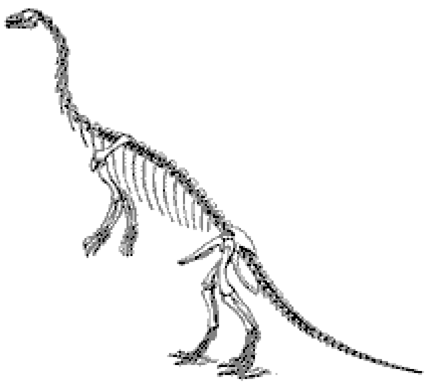
And T-Rex

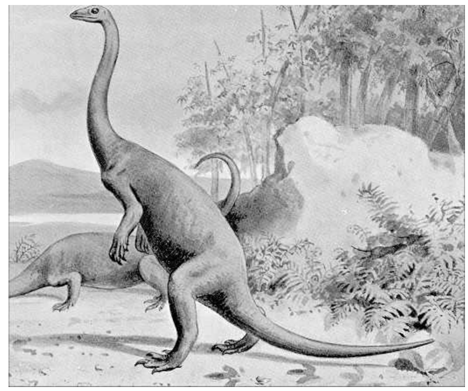


Tyrannosaurides (T-Rex)

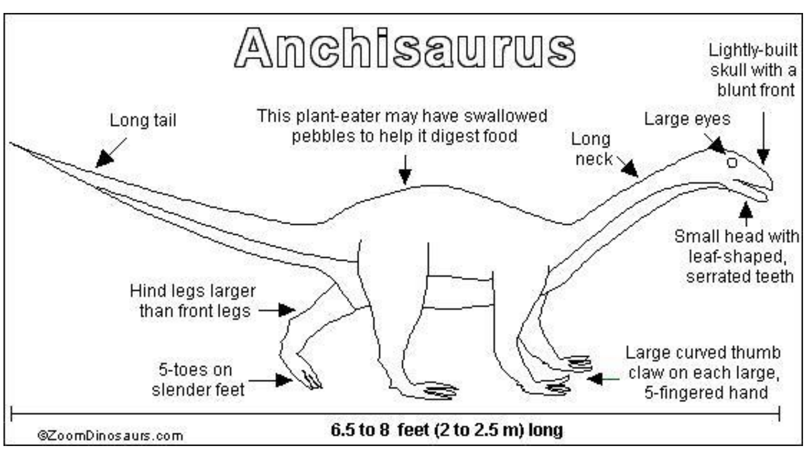
PHYTODINOSAURIA

Prosauropoda

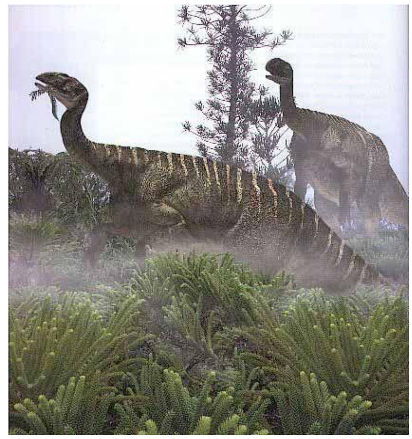




Plateosaurus (flat-lizard)



Prosauropoda (Plateosaurus)

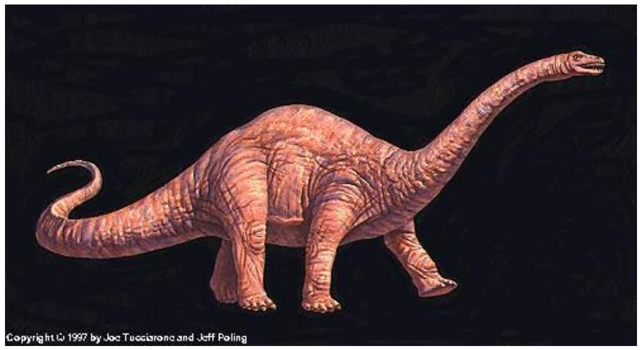
Plateosaurus (small head)

Sauropods

Who were the Sauropods?

Mainly Jurrasic

Who were the Sauropods



Apatosaurus

Z 55 na 33 metrů se zmenšil „nejdelší“ známý dinosaurus poté, co vědci přehodnotili svůj původní nález.

Na úžasnou délku dinosaura usoudili objevitelé jeho neúplné kostry z umístění 20. až 27. ocasního obratle. Lucas ale dokázal, že ve skutečnosti jde o 12. až 19. ocasní obratel a že zvíře bylo celkově mnohem kratší. Lucas navíc objevil v blízkosti nálezu kostry ještě kost zadní nohy a i její velikost potvrzuje, že původní odhady délky seismosaura byly přehnané. Srovnání detailů kostry s kostrami diplodoků zase naznačuje, že seismosaurus patřil do jejich blízkého příbuzenstva. Původní vědecké jméno Seismosaurus hallorum by se tedy mělo změnit na Diplodocus hallorum, ale Lucas si nedělá iluze, že by se „zemětřesné“ jméno ztratilo ze světa.

Scientific Name: *Brachiosaurus*
Phylum: Chordata
Class: Dinosauria
Sauropoda

The Ornithischians (bird-hip structure) - Phytodinosauria

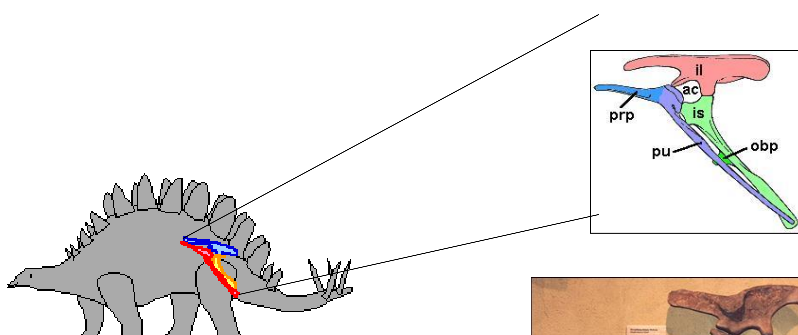
There were five basic kinds of ornithischians

- (1) stegosaurs
- (2) ankylosaurs
- (3) ornithopods
- (4) pachycephalosaurs
- (5) ceratopsians
- Each group included many different species.

Entirely vegetarians

- Exploited vegetation low to the ground

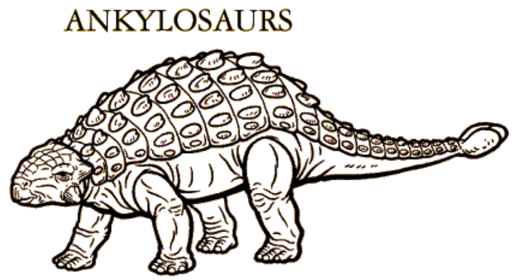
Pelvis characteristics



Ornithischian hip

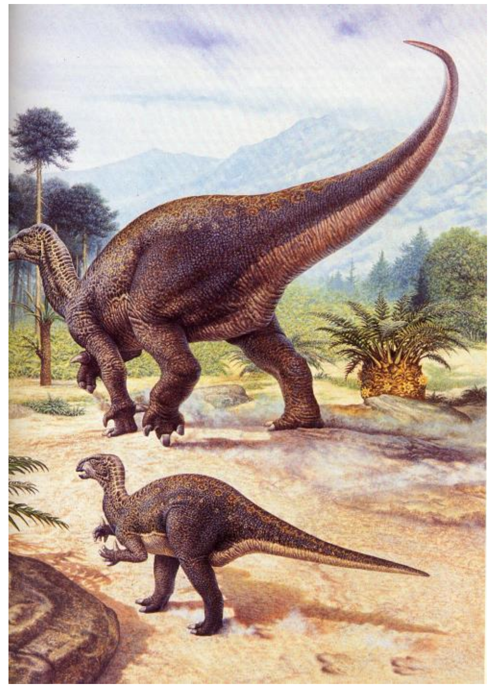
Stegosauria

Stegosaurus



Ornithopoda

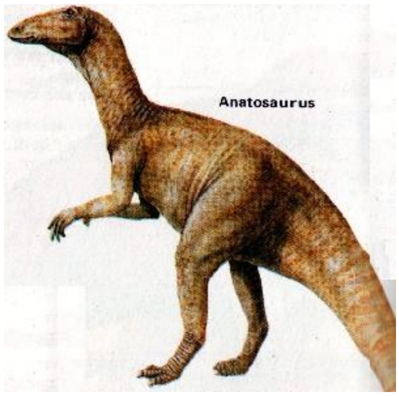
Iguanodonts



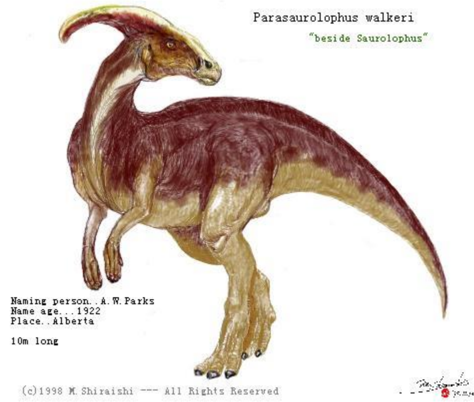
Hadrosaurs

Duck Bill Idea – Sometimes called Duck-billed dinosaur

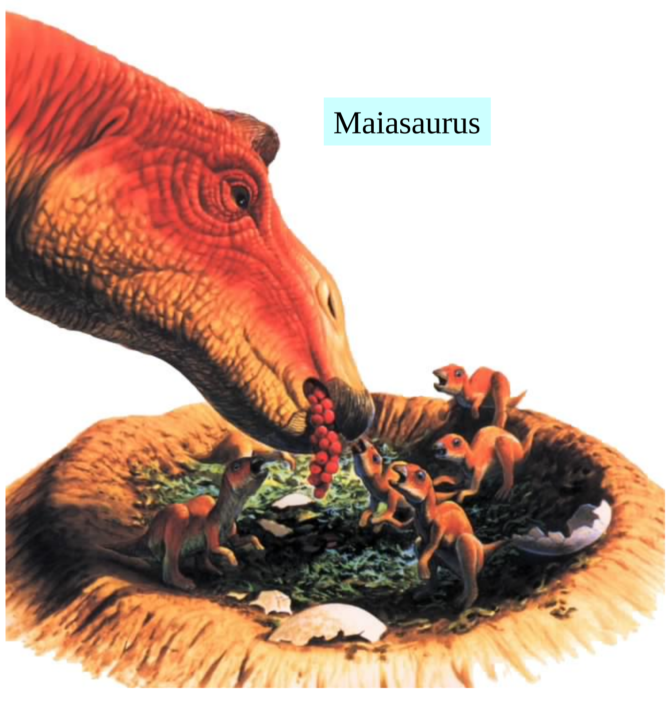
Types of Hadrosaurs



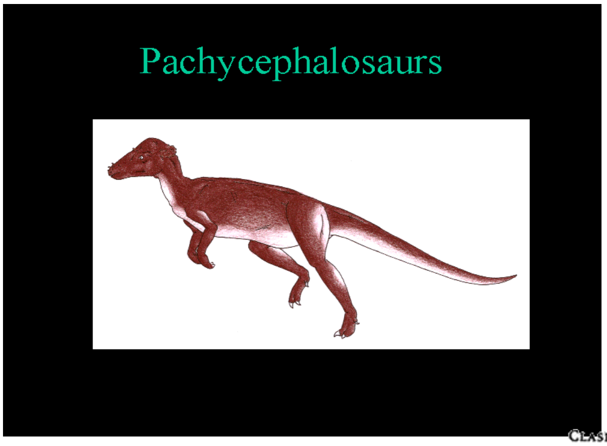
Anatosaurus

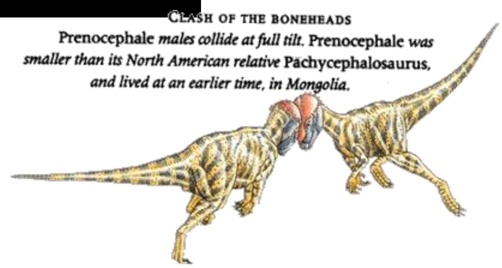


Parasaurolophus



Maiasaurus


Pachycephalosaurs


CLASH OF THE BONEHEADS
Prenocephale males collide at full tilt. Prenocephale was smaller than its North American relative Pachycephalosaurus, and lived at an earlier time, in Mongolia.

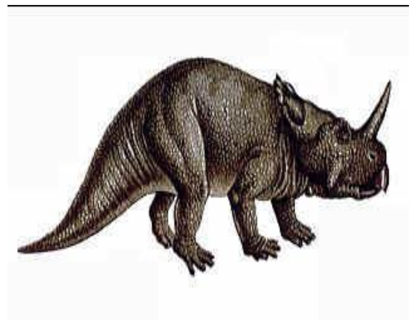
Ceratopsia

Ceratopsia

Types of Ceratopsia

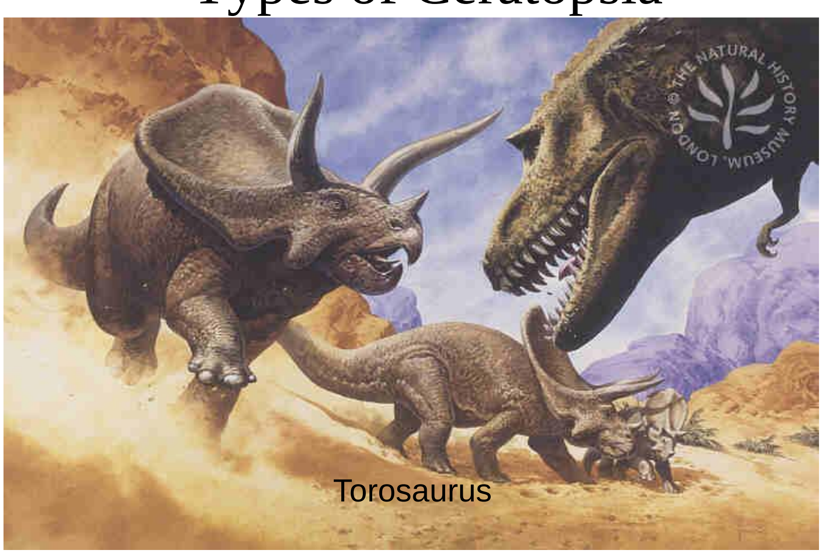
Protoceratops

Types of Ceratopsia



Monoclonius

Types of Ceratopsia

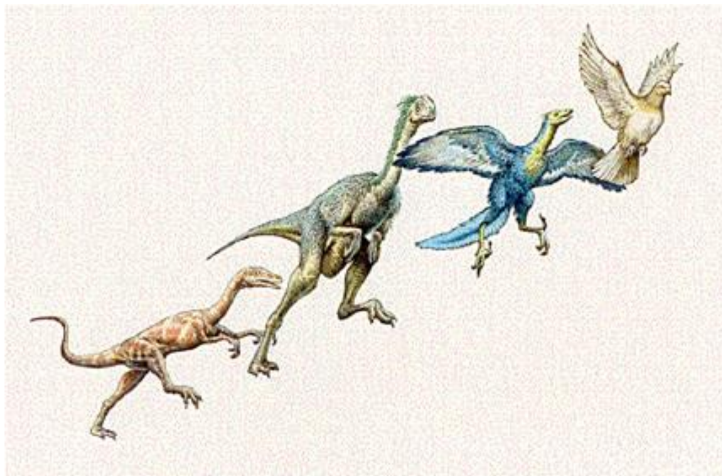


Torosaurus

Types of Ceratopsia

Triceratops

Warm Blooded Dinosaurs, Reptile Biology, Archosaurs vs. Reptiles



The Warm Blooded Dinosaurs

?
=

Warm blooded vs. Cold blooded Dinosaurs...

Definitions

- Endothermic: creates heat from inside
- Ectothermic: absorbs heat from outside
- Homeothermic: maintains a constant internal temperature
- Poikilothermic: temperature fluctuates depending on outside conditions

Bone structure

- Haversian Canals
- Most cold blooded animals lack this bone structure.

Predator-Prey Ratios: ectothermic?

- Require far less food/energy than warm blooded animals

An adult female rubber boa from southeastern Idaho

Dinosaur Communities

Superiority of predators

- Mammals generally superior to reptiles

Evidence for endothermic dinosaurs

- Fast things need to have heat available. Many dinosaurs appear to be **fast-moving**.
- Today, **endotherms normally outcompete ectotherms**. Since dinosaurs coexisted with known endotherms, they must also have been endothermic.
- Dinosaurs were **upright walkers** with legs below their bodies **- typical of endotherms**

Evidence for endothermic dinosaurs

- Dinosaurs had **big brains**, and endotherms tend to have big brains (but not always, and brain size is correlated with other things, too).
- Ectotherms aren't usually **found at high latitudes**, and dinosaurs were (but it was warmer)
- Endotherm **predator/prey ratio is usually low**, and dinosaur ratios match mammals

Evidence for endothermic dinosaurs

- Dinosaurs were big and had large, complex hearts. Complex heart matches modern endotherms.
- Dinosaurs were **ancestral to birds, and birds are endotherms.**
- Endotherms tend to grow fast, and dinosaurs were big (but who knows how long they lived?
- Dinosaur **bone structure** matches modern endotherms better than modern ectotherms

Evidence for ectothermic dinosaurs

- Dinosaurs were huge - could have been effectively homeothermic w/o endothermy
- Dinosaurs were huge - couldn’t possibly have been endothermic because they’d burn up.
- Mesozoic was warm - dinosaurs didn’t need to be endothermic
- Ectotherms tend to be scaly, and dinosaurs were (but so are birds!)

Five current thermal hypotheses (from UCMP)

- Dinosaurs were complete endotherms, just like birds, their descendants.
- Some or all dinosaurs had some intermediate type of physiology between endothermy and ectothermy.
- We know too little about dinosaurs to hazard a guess at what their physiology was like.
- Dinosaurs were mostly inertial homeotherms; they were ectothermic but maintained a constant body temperature by growing large. Small dinosaurs were typical ectotherms, maybe with a slightly elevated metabolic rate.
- All dinosaurs were simple ectotherms, enjoying the warm Mesozoic climate. But that's okay; many ectotherms are quite active, so dinosaurs could be active, too.

Geographic Distribution

PTÁCI

- Ptačí znaky Plazí znaky
- --teropodní předchůdci ptáků------------------------------------
- **stř. jura - sp. křída**
- *Protoarcheopteryx*
- *Caudipteryx* peří dlouhý ocas, ozubené čelisti,
- bipední způsob života
- ---ptáci *s.l.*--
- **svrchní jura**
- *Archaeopteryx litographica*
  asymerické peří, furkula ozubené čelisti, dlouhý ocas
- Špatný letec, mozaiková evoluce

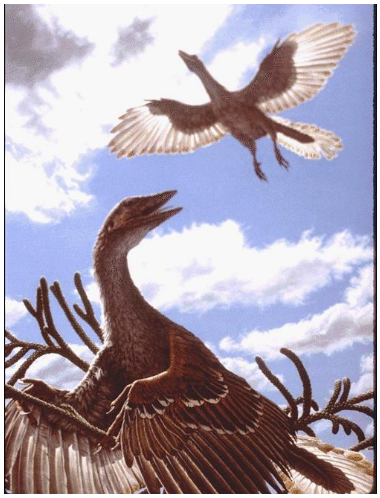
- **spodní křída**
- *Confuciusornis* peří, furkula, krátký ocas ozubené čelisti,
- drápky na křídlech
- ---ptáci *s.s.*--
- **svrchní křída**
- *Hesperornis* peří, furkula, krátký ocas ozubené čelisti
- *Ichthyornis* peří, furkula, krátký ocas ozubené čelisti

- **svrchní křída**
- skupina Neornithes - moderní ptáci

True Birds (Aves)

- Archaeopteryx long thought to be a bird ancestor
- Still hotly debated
- Ground-Up vs. Trees-Down models of flight
- This one is Trees-Down

Archaeopteryx



This one is a Ground-Up representation - they could have started flight with long leaps

Archaeopteryx is somewhat advanced, and could have made some longish flights, but likely not really well or all day.

Archaeopteryx with no artist's interpretation - (note the feathers!)

Feathers

- Feathers are obviously good for flight
- Feathers are also good insulators
- It’s not clear which property was the impetus for their evolution - Archaeopteryx might well have just been trying to keep warm.

Timing of Birds

- Birds don’t fossilize well - they have weak, light bones that are often hollow.
- From 1990-1995, the number of known bird fossils doubled.
- When did they start?
- Archaeopteryx is from Late Jurassic
- There were lots of birds, flying and flightless, by the end of the Cretaceous, including members of modern groups

Sauriurae (oposite birds) - ? Archeopteryx(Jurrasic),Confuciusornis (Jurrasic-Cretaceous)

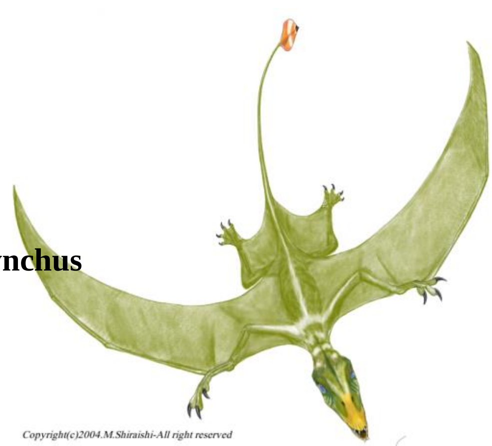
Ornithurae (modern birds) – Hesperornis, Ichtyornis (Cretaceous)

Pterosauria

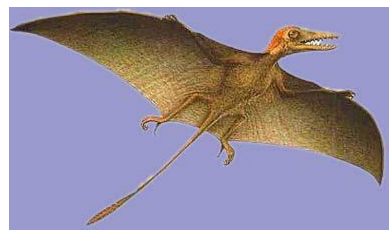
Triassic-Cretaceous

Jurrasic with tail

Rhamphorhynchus



Sordes pilosus



Quetzalcoatlus

- **PŮVOD SAVCŮ**

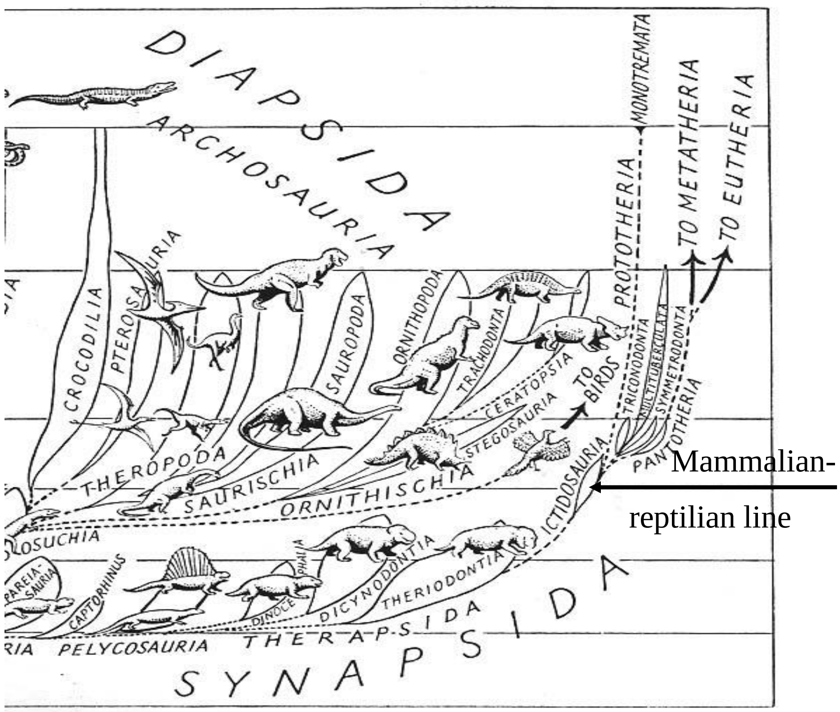
- Počátek savců - střední trias
- Polyfyletický původ z therapsidů (Cynodontia, Tritylodontia, Ictidosauria)

- **Typické savčí znaky**: teplokrevnost, srst nebo chlupy, mléčné žlázy, živorodost (s výjimkou ptakopyska)

- **Typické znaky na kostře**: kůstky ve středouší (kladívko, kovadlinka a třmínek), spodní čelist tvořená jednou kostí (dentale), dělený chrup na řezáky, špičáky a stoličky, okluze stoliček

- nejstarší savci
- Docodonta (jura)
- Multituberculata (trias - terciér)
- Triconodonta (trias - křída) → Monotremata
- Symmetrodonta (trias - křída) → Pantotheria →Placentalia
  →Marsupialia

- hmyzožravci, velikost myši, vedlejší niky,
- Vymírání K/T - uvolnění nik, rychlá radiace



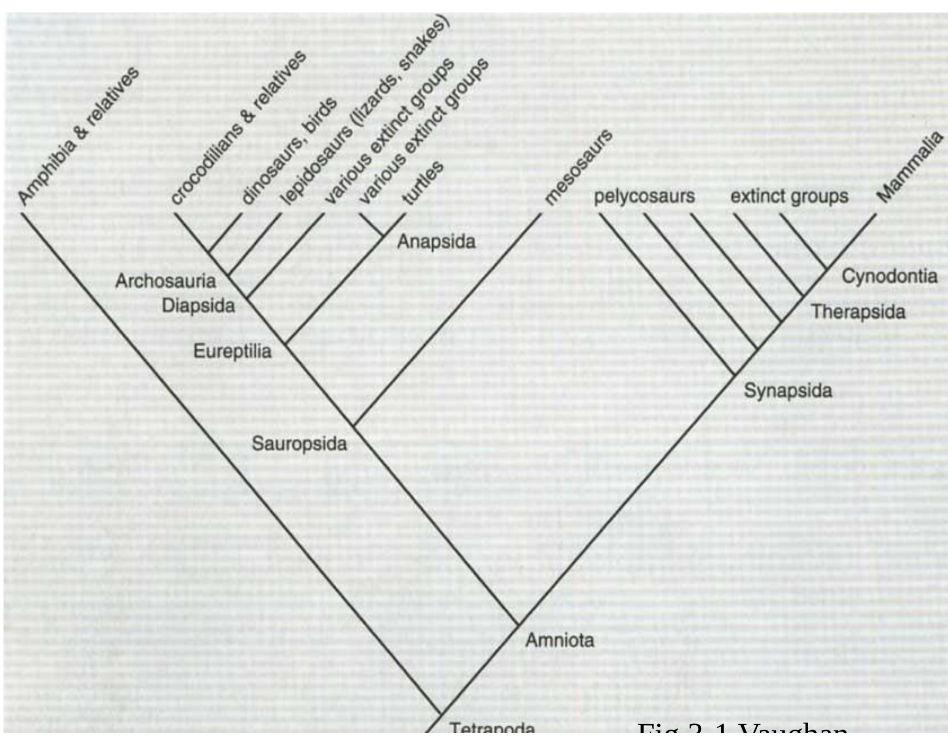
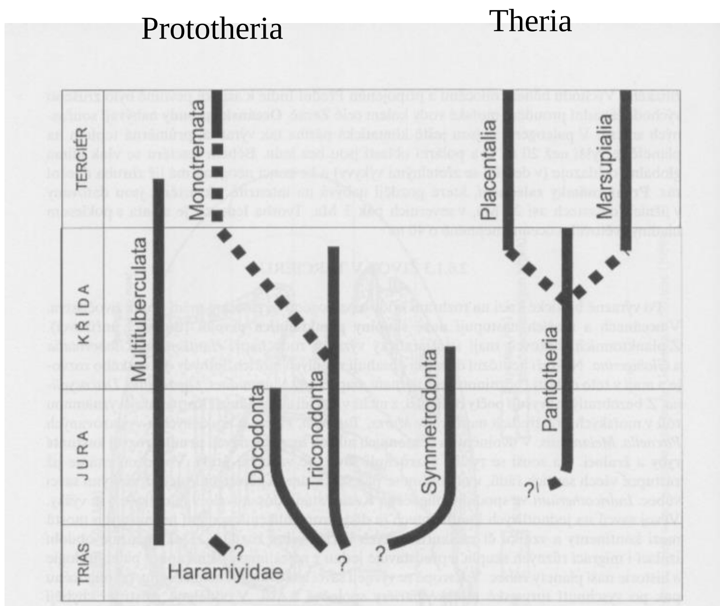


Fig 2-1 Vaughan



Obr. 85. Vývojové vztahy a stratigrafický rozsah hlavních skupin savců. Upraveno podle Wicander & Hourac (1989).

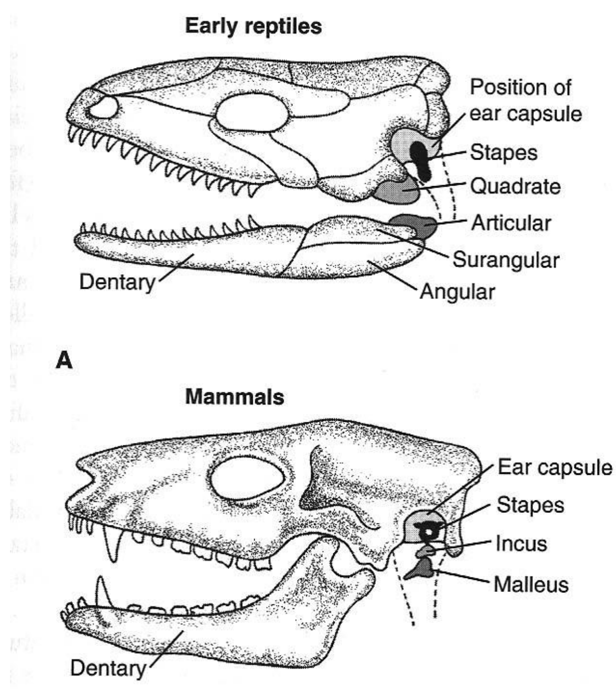


Fig 4.5 Feldhamer

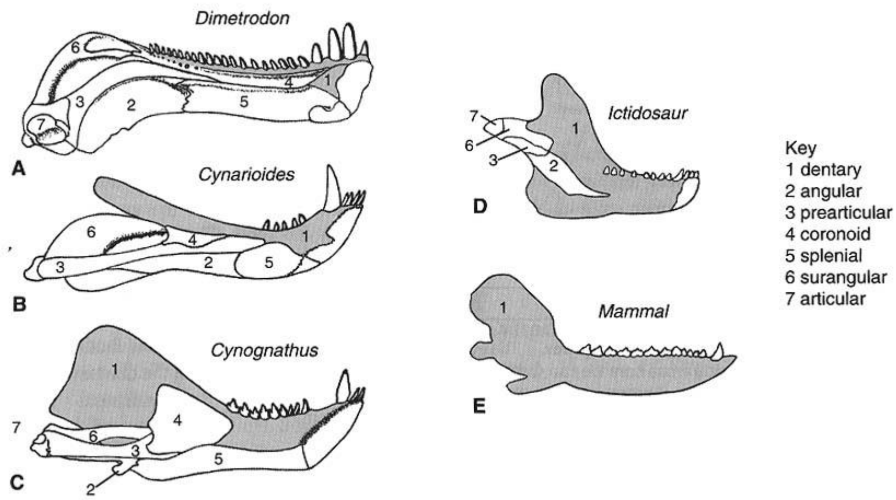


Figure 4.4 Enlargement of the dentary bone. The progressive enlargement of the dentary bone (shaded) and reduction in postdentary bones is evident when comparing jaws of primitive mammal-like reptiles: (A) *Dimetrodon*, an early Permian pelycosaur; (B) Cynarioides, a late Permian therapsid; (C) *Cynognathus*, an early Triassic cynodont; and (D) *Ictidosaur*, a late Triassic–early Jurassic cynodont. The dentary is the sole bone in the jaw of mammals (E).

Geological Time and the Evolution of Mammals:
Pelycosaurs
Therapsids
Cynodontia: the transitional Infraorder

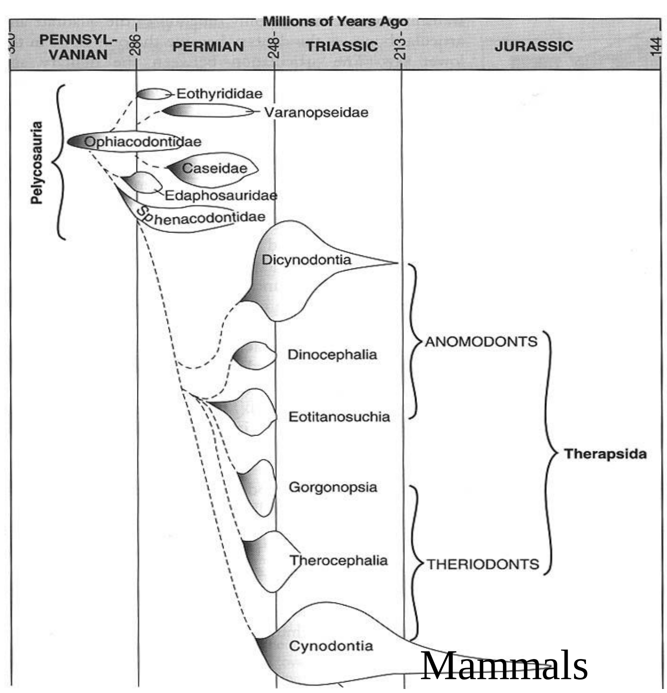


Fig 4.2, Feldhamer

Archaic Mammals of the Jurassic

Mammalian radiation of the early Jurassic

- **Tricondodontia** (3 cusps in a row) large (750 g), predaceous mammals of early Triassic
- **Monotremata**: A living example of Mesozoic mammals
  Fossil record is poor, beginning in early Cretaceous
  Thought have diverged in Jurassic
- **Multituberculata**: herbivorous, molars w/ multiple cusps
  Highly successful: from Jurassic to Oligocene (100 m yr)
- **Zatheria**: includes *Aegialodon* (with tribospenic molar) & ancestor of therian mammals (Eutheria & Metatheria)

Prototheria (<u>**monotremes**</u> and their relatives):

- Oldest fossils Early Cretaceous; survive today in Australasia as **platypus** (ptakopysk) and **echidna** (ježura)
- Still **lay eggs** (only living mammals to do so)
- Very simple mammary glands
- Today's monotremes have lots of primitive features, but many specializations of their own
- No evidence that monotremes were ever a dominant group of mammals

Triconodonta (**tricodonts**)

- Very primitive clade of mammals, restricted to the Mesozoic
- Lived from Jurassic into the Cretaceous
- Not known if egg layers, pouched, placental birth, etc.

- **VYMÍRÁNÍ K/T**
- + dinosauři, ptakoještěři, mořští ještěři, amoniti, rudisti, belemniti, někteří zástupci planktonu - coccolithophorida, planktonní foraminifery, radiolárie, angiospermní rostliny
- iridiová anomálie, kráter Chixculub na Yucatánu, impakt - požáry pralesů, zakalení atmosféry kouřem a impaktním prachem, impaktní zima, zpomalení fotosytézy, kyselé deště, atd.
- Diskuze, dinosauři na ústupu, 26 miliónů let interval masových vymírání, atd.

The asteroid impact theory was first proposed by Louis and Walter Alvarez in 1980.

They discovered high concentrations of **iridium** - an element rarely found on Earth but found in abundance in **extraterrestrial bodies** such as asteroids and meteorites - in a thin layer of clay from Italy. The iridium was found at the Cretaceous-Tertiary (K/T) boundary, the layer of geological deposits dated at 65 million years when the dinosaurs became extinct.


This theory is that an asteroid 4-9miles in diameter hit the Earth.
Since the asteroid scattered awful amount of dust and debris in the atmosphere, the dust and debris blocked the most of the sunlight, and the temperature lowed down globally. The low temperature caused the mass extinction.


Chicxulub

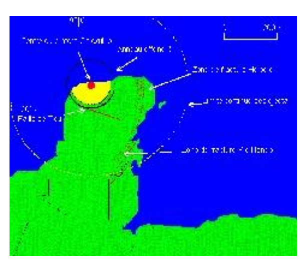
Yucatan Penisula, Mexico
180 km diameter
More than 100 times the diameter of Berringer

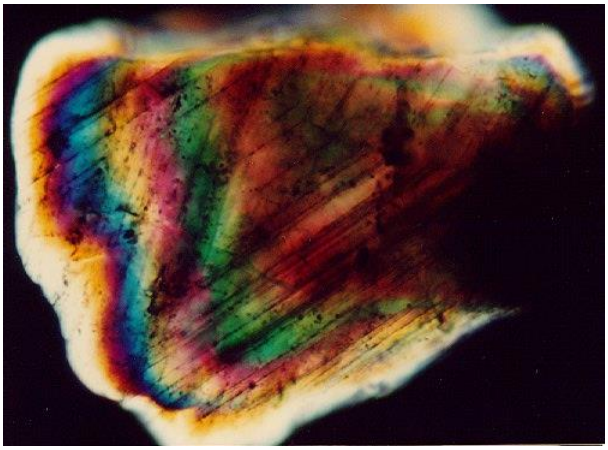
65,000,000 million years ago
Cretaceous mass extinction
Disappearance of the dinosaurs

Worldwide debris
Iridium anomaly
in clay at K/T boundary

Chicxulub Impact Site

tectites





A 0.32 mm **shocked quartz** grain from intracrater breccia sample Y6 N14 of the Chicxulub crater. The drill hole Yucatán-6 was located ~50 km from the crater's center and penetrated ~500 metres of impact melt and breccias at its base. The melt and breccia units contain clear evidence of production by impact, including mineral grains showing evidence of shock metamorphism. In the mineral quartz the passage of a strong shock wave can cause dislocation of the grain's crystal structure along preferred crystallographic orientations. This quartz grain shows at least 8 sets of planar deformation features when rotated; two strong sets (and part of a third set) of shock lamellae are visible in this orientation. The lamellae are decorated with inclusions. Impact is the only natural process known to produce shock waves of sufficient strength to cause deformation of this type.